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URINARY SURGERY

URINARY SURGERY

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A REVIEW

BY

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TO MY FATHER

PREFACE

THIS book is an attempt to review for the use of the practitioner the progress of urinary surgery during the last decade. It is hoped that it will also be found useful by those presenting themselves for the College Fellowship and the University examinations.

Urology has made rapid strides during the last ten years, especially in four directions: First, in the great improvements in the technique of ureteric catheterisation, and in the invention of numerous tests of the functioning power of the kidneys that can by this means be applied to the urine drawn off from each kidney separately. Owing to these tests the dangers of nephrectomy have been minimised to a degree little short of startling (see p. 191). Such practical results of these tests supply the best answer to those who, slow to employ them, still criticise them on hypothetical grounds. Secondly, in the introduction of the X rays for the detection of stone and the development of the clinical interpretation of X-ray shadows. Thirdly, in the development of the bacteriology of the urine, and the fresh possibilities thereby gained in the study and treatment of infections of the urinary tract. Fourthly, in the development of the surgery of the prostate.

The new facts accumulated will prove of little benefit if they are to remain in the heads and hands of a few experts. They must be brought within reach of the large number of patients suffering from urinary complaints. To attain this object the participation of the practitioner is imperatively required. It is not, perhaps, possible for a busy practitioner to be expert in all the technical manipulations required by the subject, but he can make himself conversant with the

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significance of important symptoms, and should be capable of deciding from those symptoms where a complete examination of his patient is advisable.

This book is an attempt to set forth the symptoms of urinary disease, and to connect up those symptoms with the more important signs that can be detected by cystoscopy, urinalysis, bacteriology, and radiography.

The day for treating symptoms is passing away. Take hæmaturia as an example. One way of treating hæmaturia is to put the patient to bed, give him a little ergot or opium, and in a day or two the blood will disappear from the urine, and the patient will be allowed to return to his ordinary life without any complete examination, save that the urine will be examined for casts. These being absent, the blood will be considered as of little moment. In a few months the hæmaturia will return, to be stopped once more by similar treatment, and so on for a year or two, until the prime cause of the hæmaturia will disclose itself, *when too late for curative treatment,* as an inoperable tumour of the bladder or kidney, or as a stone that has completely destroyed the kidney in which it lies buried.

A better way is to look upon hæmaturia as a warning that something is seriously amiss with the urinary organs. Hæmaturia asks a question that requires an early answer. What is the underlying cause of the hæmaturia? Is it a tumour, a stone, an enlarged prostate, a nephritis, a blood disease, and so forth? The practitioner should not rest quietly until he has satisfied himself as to the prime cause, and as to whether an early operation is urgently required.

In many branches of medicine it is being actively taught that it is against professional morality to treat certain symptoms with palliatives, for fear lest the early and favourable opportunity will be lost for removing the cause. A good instance is that of metrorrhagia in women of ripe age. If a first bleeding is neglected the favourable time for extirpating a cancer of the womb may be lost. And this should be insisted upon to no less a degree in the case of bleeding from

the urinary passages. It is during the first hæmaturia that a diagnosis of tumour of the bladder or kidney can be made with the cystoscope. If the practitioner awaits a second or third attack of bleeding before insisting upon a complete investigation the opportunity for successful operation may be lost. The point need not be laboured, but the case is equally true for the other symptoms of urinary disease—pyuria, increased frequency of micturition, difficult micturition, alterations in the urinary stream, and pain characteristic of urinary disorders.

In the following pages it is shown how hæmaturia can be tracked to its source with the cystoscope, ureteric catheters, and X rays; how pus in the urine can be detected as coming from the urethra, prostate, vesiculæ, bladder, kidneys or kidney by means of Janet's five-glass test, prostatic massage, the cystoscope, and the ureteric catheters; how the bacteria in the pus can be isolated, and the case treated if suitable by the various bacterial extracts and emulsions, and by local treatment applied to the primary focus in prostate, bladder, or kidney. As regards treatment, this is set forth in so far as it can be carried out by the practitioner, but as far as operative measures are concerned the indications for such are dealt with rather than the full details thereof, though the main features of the operations are outlined.

It has not been found possible to give complete references to the literature, but a complete bibliography up to 1907 (upwards of two thousand references) will be found in Kapsammer's monumental work, 'Nierendiagnostik und Nierenchirurgie,' and later references can be found in the 'Jahresbericht für Urologie.'

I wish to thank Mr. Hurry Fenwick for his encouragement and sympathetic guidance in the preparation of this book and for leave to make use of Plate XXX from his book, 'The Value of Radiography in the Diagnosis and Treatment of Urinary Stone.'

HARLEY STREET, LONDON, W.
October, 1910.

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SECTION I.

DISEASES OF THE KIDNEY.

CHAPTER I.

ROUTINE EXAMINATION OF A UROLOGICAL CASE; SUMMARY OF METHODS.

I. History.

A. Rough General Outline.—The onset symptom—the course, its duration, whether continuous or marked by intermittent attacks—the attacks, whether increasing or decreasing in severity and frequency—does the present attack resemble others in the past?—any former diagnoses and treatments, any instrumentation, any injury.

B. Details of Present and Past Attacks.

Pain.—Its positions—starting points—lines of radiation. Its character—dull or sharp—mild or severe—continuous or intermittent. Relation to movement, to micturition, to hæmaturia, to position. Is there anything which relieves it or makes it worse?

Frequency of micturition.—During the day and at night—relation to movement, meals, drink. Persistent or intermittent—quantity of urine passed. Worry, fear, habit.

Manner of micturition.—Power, volume, continuity, direction of stream—effect of straining. Retention, incontinence, suppression.

Hæmaturia.—Noted by patient or by doctor. Amount—character—colour—at end of micturition—apart from micturition—well mixed with the urine. Relation to pain, to movement, to injury.

Cloudy urine.—Is it cloudy when passed, or after standing? Is it offensive when passed? Passage of sand and calculi, clots, fragments of growth, etc.

General history.—Age, occupation, ever abroad. Habits of life, especially sexual habits, married or single, menstruation, drink, meals, exercise, sleep.

Venereal history.—Gonorrhœa, syphilis, chancroids. Methods of treatment.

Family history.—Tuberculosis, calculus, gout, congenital deformities, tumours, syphilis, nervous disease, hæmophilia.

Special systems—General states.—Wasting, œdema, rigors and fever, specific fevers.

Alimentary system.—Thirst, appetite, nausea and vomiting, state of bowels.

Nervous system.—Headache, fits.

Respiratory system.—Phthisis, chronic cough, dyspnœa.

Cardiac and vaso-motor.—Palpitations, dyspnœa, giddiness, faints, flushings.

II. Physical Examination.

A. Inspection, palpation, and, if necessary, percussion of each structure, proceeding in Anatomical order and from System to System.

1. *Genito-urinary* System in anatomical order.

Penis and external palpation of urethra. Scrotum. Testicles and vas. Perineum.

Rectal Examination (usually after abdominal). External inspection. Deep urethra and Cowper's glands. Prostate. Vesiculæ and vasa. Ureters. Base of bladder. Bimanual abdominal, especially in children, for contents of bladder and pelvis.

Abdomen.—Inspection as a whole, type of respiratory movement, areas of skin tenderness, areas or points of deep tenderness, rigidity local or general.

Kidneys: Inspection, palpation (see p. 58). Ureters. Other organs.

B. URINE—*Physical tests.*—Colour, smell, density, quantity in twenty-four hours.

Chemical.—Acidity, albumen, urea, chlorides (phosphates, uric acid), sugar, blood, and pus.

Microscopic.—Crystals, casts, blood, pus, bacteria.

Bacterial.—Microscope, culture, inoculation.

C. OTHER SYSTEMS.—Routine physical examination.

Alimentary.—Teeth, tongue, throat, stomach, intestine, colon, rectum, glands (salivary, liver, pancreas).

Lungs.—Especially for early phthisis.

Heart and vasomotor. — Size of heart, condition of arteries, systemic blood pressure, ophthalmoscope.

Blood. — Anæmias, leukæmias, hæmophilia, purpuras, toxæmia, septicæmia.

Nervous system.—Tabes, epilepsy, disseminated sclerosis, paraplegias, etc.

Skin.—Nutrition, dry or moist, diseases.

Skeleton.—General type, individual bones, *joints.*

SPECIAL METHODS OF EXAMINATION.

Urethra.—Janet's irrigation method and the glass tests (see p. 371), collection of pus and threads from anterior urethra and posterior urethra (microscope and culture on blood agar). Urethroscope. Bougies, dilators.

Prostate.—Secretion obtained by massage (after irrigation of the anterior urethra followed by micturition).

Vesiculæ.—Secretion obtained by massage (after irrigation of the anterior urethra followed by micturition).

Bladder.—Cystoscope. Catheters (sound).

Ureters.—Meatoscopy. Bougies. X-ray and iron oxide bougies.

Kidneys.—Ureteric catheters. Urines collected, with or without experimental polyuria, injection of phloridzin, injection of coloured substances, etc. X rays.

Surgical exploration.

After a complete collection of facts the diagnosis is made by considering them as a whole.

1. The organ or organs affected—kidney, ureter, bladder, urethra, prostate, penis, testicle, vas, vesiculæ.
2. The nature of the local disease.
3. General effects.

THE DIAGNOSIS OF KIDNEY DISEASE is concerned with two factors:

1. *The anatomical condition of each kidney.*
2. *The physiological condition of each kidney.*

1. ANATOMICAL CONDITION.

A. *To prove the presence of two kidneys* (when the question of nephrectomy arises).

1. Both kidneys may be palpable.

2. If no stigmata of congenital defect are present, and if there is no family history of defect, then the presence of two normally placed ureters as seen by the cystoscope, secreting urine (as proved by inspection or the ureteric catheter), is sufficient evidence for practical purposes (see p. 30).
3. If congenital stigmata are present "iron-oxide" bougies should be passed up each ureter and a radiogram taken. If the course of the ureters appears normal, and especially if a shadow outline of each kidney can be obtained, then the evidence is sufficient.
4. If doubt remains, exploration of each kidney by the lumbar route is justifiable.
5. A fused kidney may be found at exploration (see p. 30). There can then be no doubt that no other kidney is present.

B. *The morbid condition of each kidney.*—This is determined by a consideration of *all* the signs and symptoms, general and local, and especially the analyses of the separated urines, and the X-ray examination.

2. Physiological or Functional Condition.

The power of one or both kidneys may be normal, diminished, absent, or increased. The normal healthy kidney has a large reserve of power, which does not depend on an anatomical basis, for if one kidney has to be suddenly excised after a severe crushing injury, the opposite kidney is able to take on at once the work previously carried out by both kidneys. Anatomical hypertrophy is a later phenomenon (see p. 36).

In progressive destruction of the kidney the limits of hypertrophy are reached after a long time and compensation fails. When this is so definite symptoms begin to appear, but before that there are no symptoms to show that the reserve power is lessened or that hypertrophy has occurred.

Whether kidney substance be destroyed, or the function be depressed slowly or suddenly, there is a stage of latency or tolerance, during which no signs appear, followed by a period of "uræmia" during which some or all of a definite series of signs may be revealed. When compensation begins to break down, it may break down completely and for good and all, or the patient may continue to live on the border-line for a considerable time, showing signs of failure if submitted to excessive strain, losing the signs as soon as the strain is removed, and the minimum amount of work thrown on the damaged organ. These signs of failure are grouped under the term "Uræmia."

URÆMIA.

Ætiology.—The condition is not due to the retention of urinary products in the blood, such as urea, nor has it been possible to prove that it is due to the cutting off of a hypothetical internal secretion of the kidney. It has been suggested that the kidney in health excretes toxic metabolites, which in disease accumulate in the blood and produce uræmia, or that when the kidneys are diseased abnormal metabolites formed by the tissues enter the blood, but attempts to isolate such bodies and prove that they produce the symptoms of uræmia have so far been unsuccessful.

Certain facts for which no complete explanation can as yet be given seem to be fairly well established and throw light on many clinical phenomena.

(1) Destruction of kidney substance leads to a profound disturbance of the alimentary system, producing thirst, loss of appetite, nausea, vomiting and attacks of diarrhœa (gastritis and colitis).

(2) The late symptoms of acute uræmia, such as convulsions, paralyses, drowsiness, delirium, coma, Cheyne-Stokes' respiration, the extreme height of the general blood-pressure are due to œdema of the brain.

(3) In many cases of advanced destruction or degeneration of kidney substance there is a persistent raising of the general blood-pressure with hypertrophy of the muscular walls of the systemic arteries and the left ventricle of the heart.

Signs and Symptoms of Uræmia in Surgical Cases.

Alimentary system.—Thirst that cannot be satisfied is one of the earliest symptoms, even when the tongue is moist and clean. The tongue in surgical cases is often surprisingly moist and clean, and only in the late stages does it become tremulous, dry and coated with heavy white or yellow fur, in common with the rest of the mouth and throat.

Nausea and sporadic attacks of vomiting, especially in the mornings, are amongst the earliest and most characteristic symptoms. When accompanied by epigastric pain and hæmatemesis from high blood-pressure the resemblance to gastric ulcer is sufficiently close as to lead to mistakes if the urine be not tested carefully. Constipation is the rule, alternating with attacks of diarrhœa.

Nervous system.—Headache, chiefly frontal and worse in the mornings, is an early symptom. The pupils may be pin-point in the later stages, but in the early stages in surgical cases they show no characteristic changes. The fundi may show tortuous and thickened blood-vessels and retinal hæmorrhages, and towards the end albuminuric retinitis and œdema.

Gross twitchings of the wrist muscles and purposeless co-ordinated movements of the small muscles of the hands are early signs, and are followed by delirium, or coma vigil, deepening into complete coma, sometimes of very short duration, which brings the scene to a close.

Cardio-vascular system.—Increased vascular tension in the systemic arteries accompanied by hypertrophy of the left ventricle of the heart is a very common sign. The blood-pressure should be measured with an armlet and manometer applied to the left brachial, as it is difficult to estimate vascular tension with the finger accurately. Very striking results are obtained if accurate blood-pressure curves be kept in surgical cases. The walls of the arteries are thickened, the heart is enlarged outwards and downwards, and the aortic second sound is clear and ringing. The pulse is slow except in the terminal stages, when it may become very rapid and feeble.

Respiratory system.—Pulmonary signs of uræmia are seldom seen, except in the terminal stages such as slow respiration, expiratory dyspnœa, respiration of the Cheyne-Stokes' type, œdema of the lungs.

The skin.—This may be dry and inelastic, but only in the terminal stages, when the colour also changes to an earthy or sallow tinge.

General signs.—Wasting is not a marked feature, unless infection be added, when it comes on rapidly and profoundly.

Anæmia is often severe, but is not necessarily a marked feature.

The temperature is persistently subnormal, 96·5–97·5° F., if there be no infective complication.

Œdema of the feet and legs is uncommon, even in the terminal stages, but a puffiness of the lower lids is often met with, and is evidence of a slight tendency towards the œdematous state.

The urine.—In the earlier stages this is increased in quantity, and is of persistent low density (1005–1010), but the

total quantity of solids passed in the day is sufficient for the body needs. Persistent polyuria is the earliest sign of renal failure.

Towards the end the amount both of urine and of its contained solids is diminished below the normal, either gradually through a period of oliguria to one of almost complete anuria, or suddenly to complete anuria.

Uræmia may come on as an acute attack in acute diseases of the kidney, or it may appear as an acute attack on a chronic condition which has existed for years. In the chronic stage most of the signs of uræmia are in abeyance, the only symptom of something wrong being attacks of frontal headache and morning vomiting, chronic thirst, and slight wasting and anæmia. The temperature is persistently subnormal, and the general blood-pressure is abnormally high.

The signs of uræmia must be distinguished from those of infection of the kidney, namely, fever, rigors, sweats, rapid wasting and pyuria. In severe infections signs of acute or chronic uræmia appear on the top of the signs of infection, owing to the poisoning or destruction of the kidney substance.

The diagnosis is seldom difficult if the kidneys are known to be diseased, but when there is slight evidence of renal disease, or if the urine has not been carefully measured and examined, some of the cases are very puzzling. The vomiting, epigastric pain, and even hæmatemesis may suggest gastric ulcer or carcinoma, and the cerebral symptoms may suggest cerebral hæmorrhage or tumour.

Attempts have been made to devise tests by which the functional power of both kidneys or each kidney may be estimated before the onset of the ordinary uræmic signs. They are all subject to the same fallacies, and if only one test be performed, or if only the whole urine be taken, mistakes will often arise if complete trust is reposed on a single test carried out only once. If, on the other hand, the specimens of urine be collected from each kidney over a period of one to three hours (in doubtful cases on more than one occasion), and if most of the tests agree in accusing one kidney only, and suggest that the other is sufficient for the needs of the body, then there need be no hesitation in accepting the verdict and acting upon it by operating on, and if necessary removing the insufficient and diseased kidney. Because the

tests are not perfect it is unfair to denounce them all and discard them as worthless. Without the employment of these tests the surgeon is working in comparative darkness, and will be continually caught out by finding that he has removed the only functioning kidney. Whereas if he has made a determined effort to apply several of the best recognised functional tests, not only will he hardly ever be deceived, but he will feel if he is deceived that he has done his best, and left as little to chance as is humanly possible at the present day. Because the tests sometimes fail is no reason for not using them, and failure is far more common if the tests be not practised. Finally, the risks of applying the tests are far less than the risks of operating on the kidney without having applied them.

Tests of Renal Function.[1]

1. *The specific gravity.*—This gives an idea of the percentage of total solids, and if the quantity of urine passed be known, of the quantity of total solids. A persistent low specific gravity, 1005–1010 in the twenty-four hours' specimen, and persisting over periods of weeks, is suggestive of renal mischief, but it is surprising what a high specific gravity (1015–1025) urine passed by widely damaged kidneys may sometimes possess.

2. *The colour.*—This is a very rough guide to renal function, but a persistent deficiency of pigment with persistent polyuria and low density is suggestive of renal mischief. Even more suggestive is persistent pallor and persistent oliguria.

3. *Quantity of urine.*—The daily amount of urine passed in the twenty-four hours is measured, and the results noted over a period of a week or ten days, the patient either getting about and doing his ordinary work or being kept quiet in bed on a standard diet and known quantity of drink.

In health the amount of urine varies greatly from 30–50 ounces with the amount of fluid drunk, the amount of exercise and sweat, any irritation of the kidney and bladder, habit, the mental condition, etc. Women pass a smaller amount than men.

As a general rule kidneys on the brink of disaster per-

[1] Kidneys the victim of parenchymatous nephritis ("large white kidney") do not necessarily offer an increased resistance to the passage of urinary products, so that if submitted to "tests" they often yield reactions similar to those of normal kidneys. For practical purposes the clinical picture presented in such cases is so distinctive as to prevent any confusion arising.

sistently pass increased amounts of urine (60–100 oz.) which is pale, and of low specific gravity. Towards the end the amount may be suddenly diminished below the average, or oscillations may occur between periods of polyuria and oliguria. When infection supervenes the amount of urine is *gradually* diminished till complete anuria supervenes, but when the kidney fails from long-continued back-pressure, sudden relief of tension, or calculus irritation, anuria may come on suddenly.

4. *Estimation of urea.*—The average quantity of urea excreted in twenty-four hours by both kidneys is about 33 grms., or roughly 2 per cent. The amount varies widely with the nature of the diet, the amount of exercise, and the general state of metabolism.

To be of value estimations of urea should be made daily for at least ten days or a fortnight, and if the percentage remains persistently below 1·4 per cent. it strongly suggests damaged kidneys.

The amount of urine must be measured at the same time so that not only the percentage but also the actual amount of urea passed in a given period can be determined. This is at best but a rough method, unless careful estimations of total nitrogen are made not only in the urine but also in the food, fæces, and sweat, and it would seem that in health there may occur long periods of nitrogen retention, the urine showing low urea-content.

5. *The chlorides.*—Estimation of the chlorides takes very little time, but is of very little practical value unless the results are considered in conjunction with the results of other tests, and especially if applied to the urines separated from each kidney.

The chloride excretion is diminished by fever, exudation of serum or blood, and in conditions of starvation; it is increased by exercise, during the absorption of exudates, and with increase in the amount of chloride taken in with the food. The amount in the urine varies under these conditions from about 6 to 20 parts per 1000.

When dealing with patients resting in a hospital on a regulation diet which contains a known average chloride content, etc., the results obtained are comparable one with another, if care be taken to exclude any obvious cause for a departure from the normal other than a diseased kidney.

When a kidney is diminished in power as a general rule it finds difficulty or is unable to excrete a sufficient percentage

of chlorides, though the amount passed in the whole day may be sufficient when account is taken of the polyuria. If a comparison can be made of the urines drawn from each kidney in a majority of the cases the chloride percentage is diminished on the diseased side.

6. *Phosphates.*—The same remarks hold for the estimation of phosphates as for that of chlorides.

7. *Albumen.*—Opinions are divided as to whether or not a kidney can be healthy that lets through an appreciable amount of albumen. English authors seem inclined to the view that albuminuria may be physiological or functional in a large number of cases, but the Germans are inclined to suspect any kidney that shows albuminuria. The amount of albumen passed is by no means a criterion of the extent of the loss of renal tissue, as many severely damaged kidneys show but the slightest trace of albumen in their excretion.

Many more elaborate tests have been devised in the last few years, full details of which can be found in the writings of Kapsammer and Albarran, and in a recent book by Thomson Walker.

Such tests can be divided into two classes:

I. Tests which induce an artificial stimulation of the renal function by the ingestion of foreign materials taken by the mouth or injected under the skin. These include such bodies as potassium iodide, salicylate of soda, indigo carmine, methylene blue, rosanilin, phloridzin, hippuric acid, water (artificial polyuria).

Only three of these methods have stood the tests of time and are of practical value:

(1) *Phloridzin test.*—After the injection of the glucoside phloridzin the kidney substance manufactures a certain amount of sugar and excretes it in the urine. One c.c. of a 1 per cent. freshly boiled watery solution of the drug is injected beneath the skin of the thigh, and the urine is collected every few minutes into separate test-tubes. In health sugar should appear in the urine in from ten to fifteen minutes at the earliest and half an hour at the latest. The less healthy the kidney the longer does the sugar take to appear. If the sugar appears in ten to fifteen minutes at least one kidney is good enough. If only after thirty minutes both kidneys are depressed in function. If not for forty-five minutes neither kidney is good enough, and there is no need for further tests. With a catheter in each ureter the urine from each kidney is tested for sugar every few minutes, and

in this way a very accurate idea of the power of each kidney is obtained by noting the time of appearance of the sugar. The amount of sugar and the time of disappearance cannot usually be accurately measured, and are not essential for the test.

(2) *Indigo carmine.*—This substance is superior to methylene blue as a testing substance, as it appears more quickly in the urine after injection, and does not possess a colourless chromagen. Dissolve ·4 grm. of carmine in 10 c.c. of physiological salt solution. Inject 4 c.c. into the quadriceps cruris. A blue colouration should appear in the urine in from ten to twelve minutes, and give its greatest intensity in half an hour. If the appearance is delayed for more than half an hour and if the intensity of colouration is only a faint green, then the kidney or kidneys are diseased.

(3) *Artificial polyuria.*—This test is applied by Albarran to the urine obtained in a period of three hours by means of the ureteric catheter. The patient drinks 600 c.c. of Evian water and the ureters are catheterised, half-hourly specimens being then obtained, and estimation made of the amount of water, urea, chloride, and of the specific gravity. On the side of the healthy kidney the amount of water rapidly rises (artificial polyuria) and the percentage of solids sinks, but the absolute amount of solids rises. On the side of the diseased kidney the variations are much less. It is usual to apply this test only if the first two tests have left the surgeon still in doubt, when it may give valuable confirmatory evidence.

II. Tests which attempt to estimate the total salt or "ion" content of the urine and serum by means of cryoscopy (estimation of the freezing-point), or by determining the electrical resistance:

(A) *Cryoscopy, or estimation of the freezing-point.*—This method is little more than a highly elaborate way of estimating the specific gravity of the urine or serum. As it is difficult, takes a long time, and requires large amounts of blood and urine, and tells no more than the specific gravity, it is already falling into disuse.

(B) *The estimation of the electrical resistance* of the urine and serum gives an easy and accurate measure of the number of free ions contained in the two solutions. It is of some value if applied to the separated urine from each kidney and to the blood-serum obtained at the same time, but as the apparatus required is costly and needs to be kept in constant

use, it is a method that can only be of value to the specialist.

These tests can be applied to the bladder urine, which represents the total urine of both kidneys, and if it is clear that both kidneys are hopelessly depressed in function there is no need nor is it advisable to proceed further.

If on the other hand the results show only a medium depression, or no depression at all, and it is desired to compare the power of each kidney, then both ureters must be catheterised and the tests applied to the separated urines.

Separators such as those of Luys or Cathelin are more liable to fallacy and more damaging to the wall of the bladder than the ureteric catheters, so that we hesitate to employ them.

Ureteric Catheterisation.

The fallacies.—If the urine be collected only for ten minutes to half an hour a ureteric reflex irritation of the kidney may be produced. It is found by experience that a catheter in one ureter may lead to a cessation of secretion, a diminution in secretion, or an excess of secretion in one or both kidneys. This effect only lasts a few minutes, half an hour at the most, so that the average results of analysis of urine collected for two or three hours tends to eliminate the error.

If the catheters do not fit the ureters snugly leakage into the bladder may occur; therefore after ureteric catheterisation a catheter is passed into the bladder and the amount of fluid withdrawn noted. In this way it is possible to say whether there has been any leakage around the ureteric catheters. If there has not been any leakage, it is possible to use the figures obtained for the amounts of urine drawn off from each kidney, and determine the absolute amount of urea, chloride, sugar, etc., passed by each kidney during the time of the experiment. If there has been leakage no accuracy can be attached to such determination, and we have to remain content with noting the times of appearance of sugar, pigment, etc., and estimating the percentage values only of the urea, chloride, etc.

If the urine from one kidney gives a healthy reaction to all the tests, and reveals no other signs of disease, there can seldom be any doubt that this kidney can suffice for the needs of the body if care be taken not to throw it out of action by causing shock and lowering the blood-pressure, by the exces-

sive action of poison, such as ether and chloroform, or by ascending infection. Still a kidney with a gross anatomical lesion, such as a neoplasm, may sometimes give a healthy reaction to all the tests.

If, on the other hand, there are signs pointing to disease of one kidney only, such as tuberculosis, neoplasm, or intermittent hydronephrosis, and yet the tests show that the opposite kidney is depressed in function a difficult problem arises, which can only be solved by the judgment of the surgeon in each individual case. Evidence constantly accumulates to prove that a "reno-renal reflex" undoubtedly exists, and that disease of one kidney can depress the function of the other kidney by way of the nervous system and the "secretory nerves" of the kidney. The best-known instance is a case reported by Albarran, where, after nephrectomy, he left a drainage-tube impacted on the renal plexus. The opposite kidney, though having previously given healthy reactions, showed signs of failure until the drainage-tube was removed, when the kidney was restored at once to a healthy state.

Again, in tuberculosis, and possibly in neoplasm, circulating "toxins" appear to be produced, which not only depress the power of the opposite kidney, but set up mild attacks of inflammation in it.

It is found that patients with chronic back-pressure, subacute infection, or calculous disease come into the hospital fresh from the stress of active life with general signs of kidney breakdown and the results of the functional tests seem to suggest that the function of both kidneys is hopelessly depressed. But if these patients be kept at rest in a warm bed on appropriate diet, with copious drinking of bland fluids and infusion of salt solution, and if efforts be made to relieve the back-pressure gently and gradually, or diminish the infection, then it is found that in a week or ten days not only do all general signs of kidney failure disappear but also the reactions to the tests become greatly improved. Experience shows that operative measures may be safely carried out on such patients after all when the kidneys have been given a chance to rest and recover their lost ground, whereas operation at the time of admission would certainly have been fatal.

All tests, then, must be carried out, regard being had to the whole condition of the patient, and after due time has been allowed the kidneys to adjust themselves to improved conditions of rest and general hygiene. In this way we have seen

cases at first judged hopeless steered through a severe operation, and restored to an active life with kidneys reacting normally to tests, and capable of carrying on their function through a moderately active existence.

The fear of infecting a healthy kidney has been urged, but it is found by experience that if the bladder be first thoroughly washed out with oxycyanate of mercury (1 : 2000), and the catheters passed quickly into the ureters without touching the bladder-walls, and if before withdrawal a drachm of strong silver solution be injected through the catheters, infection does not occur.

CHAPTER II.

DEVELOPMENT OF THE KIDNEY AND URETER: CONGENITAL DEFECTS.

SOME knowledge of the development of the kidney and ureter is essential at the present day for the proper appreciation of many clinical states, and serves to bind together and imbue with interest certain facts that otherwise appear of little significance and are difficult to remember. *Regressive variations and mutations occur so frequently in the uro-genital system that it is impossible for the clinician to neglect them.* The frequency can easily be explained on biological grounds. The mammalian or metanephric kidney has arisen comparatively late in phylogenetic evolution, to take the place of the mesonephros and pronephros of the lower vertebrata, and has not yet had time to become fixed in type. As evolution proceeds the type of organs tends to become more stable and the tendency to variation is bred out.

Facts of development continually need to be referred to as throwing light on many obscure questions, so that at this point it is only necessary to refer very shortly by way of summary to the conditions in which the facts will be made use of. They serve to explain the presence, meaning, and varieties of "solitary kidney," a condition never to be forgotten when nephrectomy is being considered, and of "horse-shoe" and other forms of ectopic kidneys which may suggest a diagnosis of pathological abdominal tumour, and may cause trouble by obstructing labour. Some cases of movable kidney receive their explanation as conditions of congenital ectopia, and most of the causes of unilateral hydronephrosis are found to be of germinal origin. Polycystic kidneys and single cysts of the kidney can be explained, and a fairly satisfactory embryological classification of renal neoplasms can be set up, and the varying characters of such tumours felt to have meaning.

The frequency of occurrence of minor degrees of congenital abnormality has undoubtedly been under-estimated by the older writers, taking the routine post-mortem findings. Unless special attention is being paid to the subject minor

abnormalities are completely missed or are not noted in the records. Abnormal arteries and persistent fœtal lobulation are the two most common of these minor abnormalities. The figures for the major abnormalities are less erroneous, but they are vitiated by the difficulty of deciding as to whether atrophic kidneys and abnormally placed kidneys are due to congenital (germinal) or acquired (somatic) causes.

Henry Morris states that one instance of solitary kidney will occur in every 2400 autopsies, of "horse-shoe" kidney one in every 1000 autopsies, and of atrophy of one kidney even more frequently, these appearing to be the commonest abnormalities. Brewer, in a recent research, in 151 autopsies found aberrant arteries in 56 per cent., and four cases of split ureters. Our own experience in the post-mortem room, when looking out for such abnormalities, agrees with that of Brewer, and we found aberrant arteries to be extremely common.

Fortunately for the surgeon variations in one part tend to be correlated with variations in other parts—that is to say, when congenital defects *of the kidney* are present, similar defects will often be present, not only in the rest of the urogenital tract, but elsewhere in the body. Defects of the testicle and penis and of the female genitalia are especially common, and we would draw attention to the importance of noting not only minor degrees of hypospadias, but the presence of minute para-urethral follicles and canals round the penile meatus, which are very frequent and are congenital defects. *Such conditions should be looked upon as stigmata of a tendency to congenital defect.* Renal operations should never be undertaken lightly upon such subjects until the presence of two functioning kidneys has been adequately determined. The surgeon should accept such minor stigmata as danger signals.

Before proceeding to classify defects of the kidney we append a short account of the development of the kidney and ureter. This account is largely taken from the revised edition of 'Quain's Anatomy' by Bryce, from articles by Pohlmann and his pupils, and from Professor Arthur Keith's books and lectures.

Embryology; Development.[1]

"The excretory system first appears as a longitudinal duct and a longitudinal series of epithelial tubules in the part of the

[1] Portions in inverted commas (and Figs. 2, 4, 5, 6) are taken from 'Quain's Anatomy,' vol. i, new edition, T. H. Bryce. We are indebted to Prof. Schäfer and to Messrs. Longmans for leave to make these extracts.

mesoderm named the intermediate cell mass [Fig. 2, *w.d.*, *w.b.*]. This forms a continuous blastema from which every part of the system takes origin. The tubules are developed from before backwards, and are grouped as they appear in time and place into three systems, the pronephros, the mesonephros and the metanephros [Fig. 1].

"The pronephros is represented only by vestiges in the mammalia, and in the human embryo is probably to be recognised in a longitudinal duct, some blind tubules, a peri-

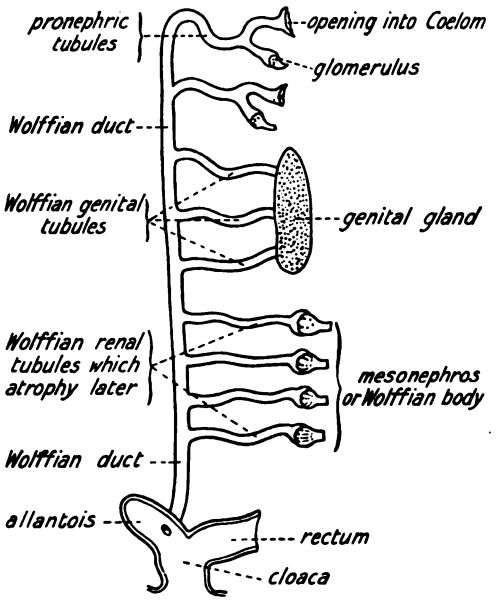


FIG. 1.—Scheme of the Wolffian body on the right side. After Keith.

toneal funnel, and a vestigial glomerulus which have been described in the fifth, sixth and seventh segments.

"The segmental or Wolffian duct appears as a solid cord of cells which extends backwards close under the ectoderm external to the nephrogenetic cord as far as the cloaca. It soon acquires a lumen and comes to open into the cloaca [Figs. 1 and 2]."

It is disputed by embryologists as to whether this duct is formed by an ingrowth of ectodermal cells inwards into the mesoderm, or by the differentiation of mesodermal cells. An ectodermal origin is suggested not only by the phylogenetic

origin of the duct but also by the tumours which arise from it (carcinomata of a squamous cell type [see Ch. X] which closely resemble the tumours of the anterior urethra, undoubtedly an ectodermal structure).

Mesonephros or Wolffian Body.

"The mesonephros appears as a ridge (Wolffian ridge) on each side of the attachment of the primitive mesentery, which extends from the fifth cervical to the fourth lumbar segment.

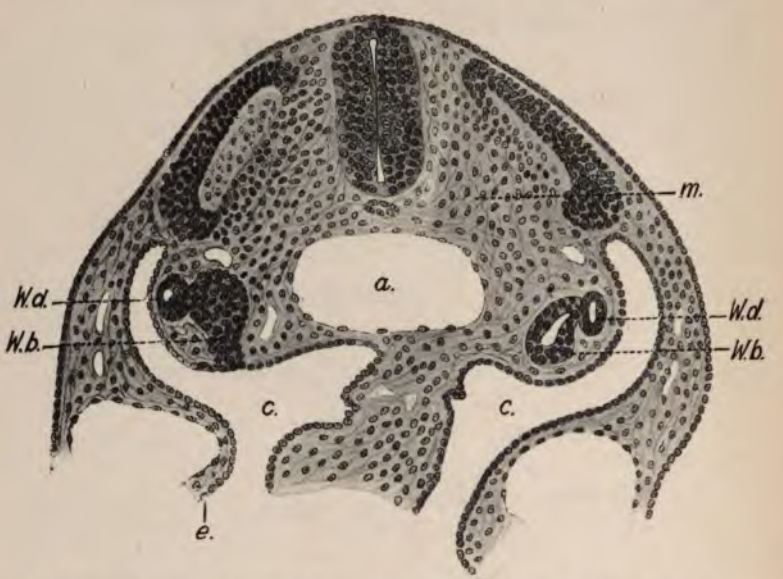


FIG. 2.—Rabbit embryo of eleventh day. After Bryce. *w.d.* Wolffian duct. *w.b.* Wolffian body. *e.* Entoderm. *a.* Aorta. *c.* Cœlom. *m.* Mesenchyme.

It is formed by the enlargement of the intermediate cell-mass, as the tubules and their Malpighian corpuscles develop in its tissues" [Fig. 2, *w.d.*]. (The tubules [Fig. 2, *w.b.*] are formed by the ingrowth of the cœlomic endothelium [Fig. 2, *e.*] into the mesenchyme of the intermediate cell-mass, to join outgrowths from the Wolffian duct.) "As the tubules increase in number the ridges become prominent bodies, which increase in size until the eighth week, after which they gradually diminish owing to the fact that the tubules undergo degenerative changes. These degenerative changes

begin at an early stage in the head end of the Wolffian body . . . and by the fifth month the tubules have

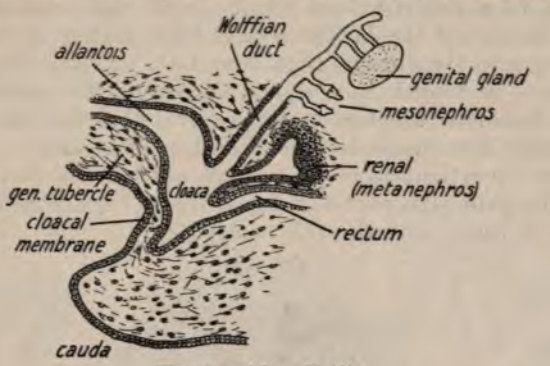


FIG. 3.—After Keith.

almost entirely disappeared, and in the end only persist as accessory parts of the reproductive apparatus (organ of Giraldes, vasa aberrantia of Haller)."

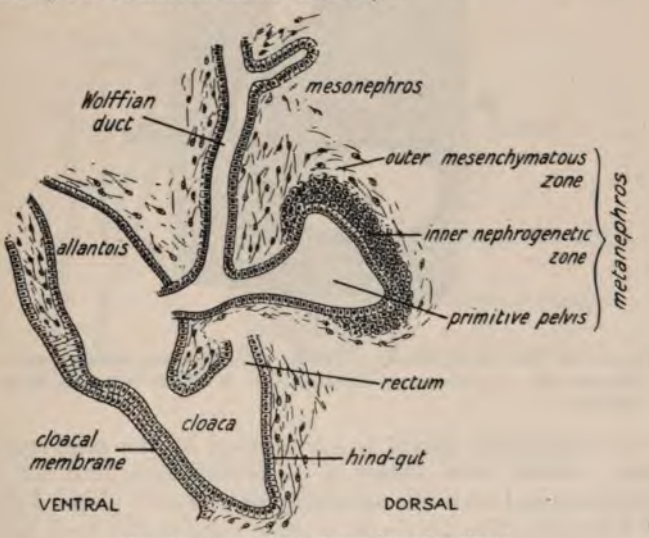


FIG. 4.—Longitudinal section of embryo.

Metanephros ; Permanent Kidney.

"The metanephros arises from the posterior part of the same nephrogenetic cord as forms the blastema of the mesophros [Figs. 2 and 4].

"The tissue, however, remains passive during the time when the tubules are forming in the Wolffian body, and becomes related to a diverticulum which grows out from the dorso-mesial aspect of the Wolffian duct immediately in front of its opening into the cloaca [Figs. 3 and 4]. As the diverticulum increases in length in a dorsal direction, the nephrogenetic tissue becomes displaced and separated from the Wolffian duct until it comes to lie *dorsal* and *mesial* to it.

"The diverticulum becomes expanded at its distal end to form the primitive pelvis of the kidney [Figs. 4 and 5], while the stalk represents the future ureter.

DORSAL.

VENTRAL.

FIG. 5.—*g*. Gut. *b*. Bladder. *i.z*. Inner nephrogenetic zone of mesenchyme cell. *p*. Pelvis. *u*. Ureter. *w.d*. Wolffian duct. *m*. Mesenchyme.

"The primitive pelvis is surrounded by the nephrogenetic tissue, which now shows a differentiation into an inner epithelioid and an outer mesenchymatous zone [Figs. 4 and 5].

"The primitive pelvis is at first simple, but soon becomes branched by the outgrowth from it of bulbous ampullæ, each of which is covered by a cap of the epithelioid inner zone, which has been broken up into separate masses during the process of branching [Fig. 6A].

"The *collecting tubules* are formed by a continuous process

of dichotomous budding from the primary branches of the pelvis. The *secretory tubules* on the other hand arise quite independently from the 'inner zone' of the nephrogenetic blastema, while the 'outer zone' provides the connective-tissue framework and capsule of the organ" (Fig. 6 B and C).

(The cells of the inner zone, though epithelioid in character, are either differentiated *in situ* from the mesenchyme cells of the intermediate cell mass, or are formed by the segmental

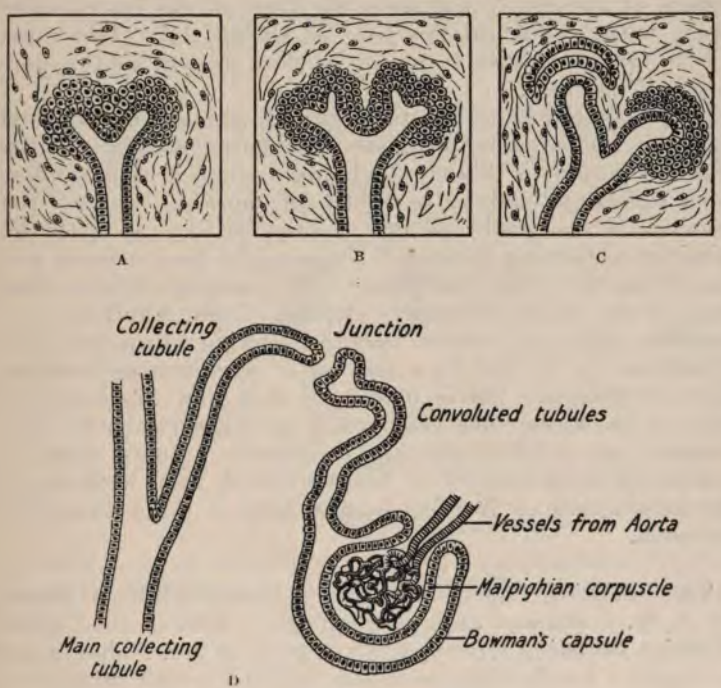


FIG. 6.

ingrowth of the endothelioid cells lining the primitive cœlom. In either case their origin is mesodermal.)

"*Origin of the tubules.*—At each division of the primary collecting tubules the inner zone cap becomes divided into two [Fig. 6 A, B]. The peripheral part of each moiety becomes the cap of the new branch; but the central portion of each becomes separated off as a detached oval and solid body which lies in the angle between the side branch and the main stem of the duct" (Fig. 6C).

A lumen appears in the solid rudiment (Fig. 6C), and from the upper extremity of the vesicle passes a diverticulum which abuts against and finally opens into the collecting duct (Fig. 6D).

The secretory tubules are all developed by a process of growth in length and folding of this primitive vesicle, the extremity becoming unfolded and invaded by a capillary cap to form Bowman's capsule and the Malpigian corpuscle (Fig. 6D).

In this way a growing area is constantly found on the surface of the cortex and along the lines of the interlobular septa, when fresh tubules can be budded off. This must persist into adult life to secure normal growth and hypertrophy if required.

If this account be correct the secretory cells are mesodermal and their tumours are sarcomata or endotheliomata; and the origin of polycystic kidney (and single cysts) is easily understood and explained by a failure of more or less of the primitive closed nephrogenetic tubules to join up with the primitive collecting tubules. Cysts might then arise at any time in the life of the individual. It is only fair to state that many of the older anatomists (Remak, Toldt, Kölliker, etc.) consider that the whole tubule-collecting, secretory and glomerular, is derived by a process of dichotomous budding from the primitive pelvic buds. In this view the secretory cells of the kidney are ectodermal or entodermal and their tumours are carcinomata, and polycystic kidneys must be considered to be derived, as Shattock held, from inclusion of the mesonephric or Wolffian body tubules in the metanephric blastema.

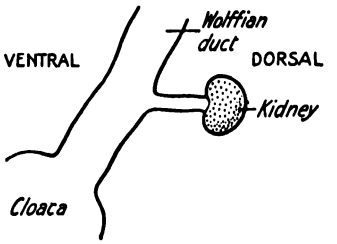
The following remarks are freely abstracted from papers by A. G. Pohlmann and his pupil E. C. Hill in the 'Johns Hopkins Bulletin,' February, 1905, p. 51 *et seq.* They serve to supply a key to many problems connected with diseases of the kidney, and to enable many disjointed observations and facts to be fitted together and be more easily remembered.

1. The renal bud arises as a dorsal outgrowth from the Wolffian duct after that duct has grown backwards to reach the cloaca, and at a short distance from its entrance into the cloaca at the level of the *second sacral vertebra.*

2. The two buds grow dorsally, lying close together, each being capped with a mass of mesenchyme.

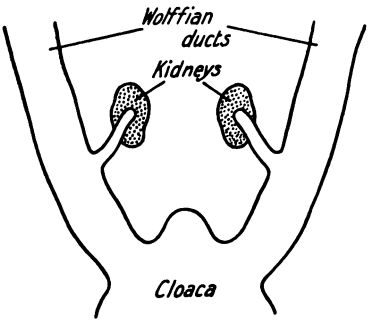
3. Each bud divides into an upper and lower sprout at some distance from the Wolffian duct.

4. The primitive kidneys *migrate upwards* from their position close together in front of the second sacral vertebra



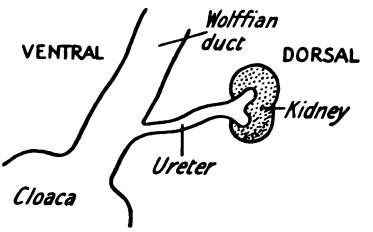
Side view.

and having reached the level of the third lumbar vertebra they undergo a *rotation or twist,* so that the hila now look



Front view.

inwards towards each other instead of ventralwards. Towards the end of the second month of fœtal life the kidney buds reach

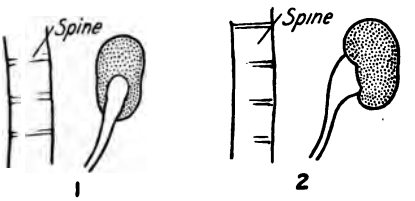


their normal height, the hila opposite the first lumbar vertebra, the rotation outwards being complete.

5. So far the metanephric kidney bud has possessed *no blood supply,* and it is only after the kidney has reached its

proper position in the loin that blood-vessels grow out from the aorta and vena cava and vascularise the renal bud.

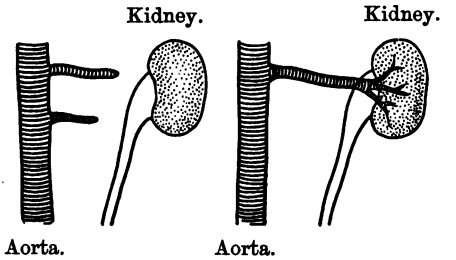
6. The lower end of the ureter changes its position (acquires *a fresh* opening into the uro-genital sinus), and comes to open independently of the Wolffian duct (vas deferens), and at the same time undergoes a rotation laterally round the Wolffian duct. This explains the numerous congenital defects, strictures and abnormal openings found in the lower end of the ureter.



Front view. 1. When kidney is in pelvis. 2. When it has reached the loin.

Some authorities state that the kidney begins to secrete urine from the third month onwards; others state that under normal conditions no urine is secreted until term, except in certain pathological conditions when the placenta fails to carry out the excretory functions of the fœtus.

It is a significant fact that as the metanephric kidney becomes vascularised and increased in size, the Wolffian



body or mesonephric kidney undergoes atrophy *pari passu*, suggesting that the two bodies carry on a vicarious function.

We are now in a position to understand—

(1) The various abnormalities in number, form and position of the kidneys.

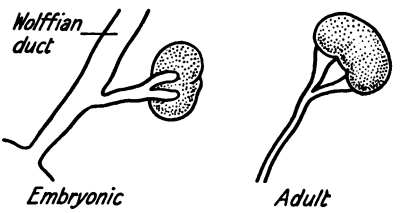
(2) How readily abnormal vessels may grow out from the aorta or other vessels to vascularise the kidneys.

(3) How it is that twists can arise in the ureter and lead to hydronephrosis.

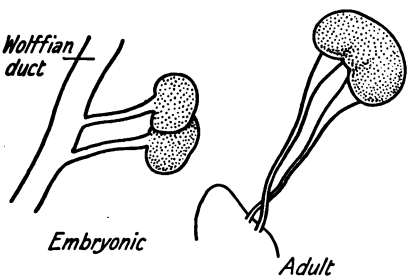
A. Changes in Form of the Ureter.

The normal division of the pelvis and primitive kidney into two early in fœtal life disappears (later) in the course of normal development. If the condition persists or becomes more fully developed, cases arise of double pelvis and double ureter, partial or complete. Hence the rule holds that *the ventral or inner ureter always arises from the upper pelvis.* The kidneys themselves may be normal or abnormal.

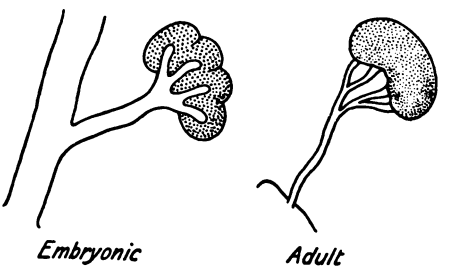
A 1. Incomplete double ureter; pelvis double, ventral ureter from upper pelvis, one lower orifice normally placed.



A 2. Complete double ureter.

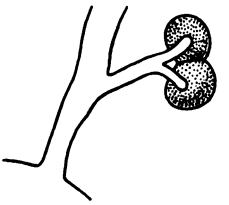


A 3. Multiple pelvis and ureters; four pelves.



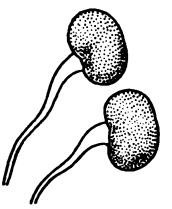
B. Variations in Form of One Kidney.

As the pelvic bud grows into the mesodermic blastema the blastema may remain single or may become divided into two parts. In this way supernumerary kidneys arise.



Embryonic

B 1. *Complete Double Kidney.*
Again the inner ureter goes to upper kidney.



Adult

B 2. *Fused Supernumerary Kidneys.*
1. Not visible externally except a double ureter.
2. Demarcation clear.

1 2 3

3. Fusion occurs late after one has already rotated, the other not.

C. Changes in Form involving Both Kidneys.

Horse-shoe kidneys are formed by the fusion, more or less complete, of the two mesenchymatous blastemata, as they lie

together while rising out of the pelvis. This is why horse-shoe kidneys are always ectopic kidneys, and lie either in front of the sacral promontory, or low in the loin ("sigmoid" form). The sigmoid form arises when fusion occurs after one kidney has moved up earlier and higher than the other. Fusion may also occur with both kidneys parallel or with one kidney dorsal to the other. In this way can be explained most of the reported forms of "horse-shoe" kidney, and all

1 2 3

the possible forms that might be expected to arise can be worked out, though actual specimens of some of the forms have not so far been described, but without doubt they will eventually be found and described. In the same connection the ventral ureters of horse-shoe and sigmoid kidneys are easily understood.

4 5 6 7

Fusion of kidneys.

(*a*) In same relative positions.
  1. Upper pole fused—rare variety.
  2. Lower pole fused—common variety.
  3. Middle—"discoid."

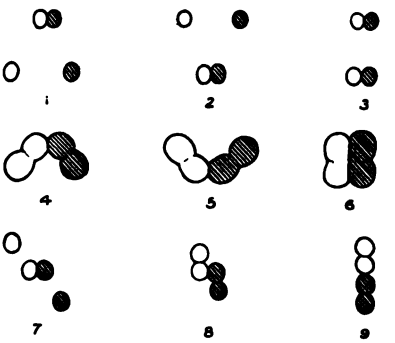
(*b*) One ventral to the other (4).

(*c*) One higher than the other—"sigmoid" kidneys (5, 6, 7).

(5) Slight.

(6) Upper to lower pole, both not rotated.
—upper rotated (7).

Fusion of supernumerary kidneys of opposite sides (possible varieties).



Fœtal Lobulation.

In the fœtus at term the kidney surface is marked out into ten or twelve lobules, which correspond to the ten to twelve primitive divisions of the pelvic bud or calices, separated from one another by delicate fibrous membranes. As growth proceeds the hollows become filled up with parenchyma cells, and the smooth adult kidney is produced.

In lower mammals this primitive lobulation of the kidney is preserved throughout life, and in the human it persists not uncommonly in company with other stigmata of regression, such as abnormal blood-vessels, kinks of the ureter, etc. At the same time any acquired causes of back-pressure may cause the fœtal lobulation, never quite lost, to reappear from accentuation of the lobular lines.

Lobulation of the kidney encountered at operation means one of two things :

1. A congenitally defective kidney.
2. A kidney long subject to intermittent back-pressure.

Valves and Kinks of the Ureter.

As already described, the upper end of the ureter under normal conditions undergoes a rotation with the kidney at the end of the second month of fœtal life, so that the kidney, originally lying dorsal to the ureter, comes to lie on its outer side. The lower end of the ureter not only acquires a new attachment, leaving the Wolffian duct to open into the uro-

genital sinus, but also appears to undergo a rotation to the outside and then ventralwards with regard to the Wolffian duct.

The fœtal ureter[1] is found not to be a smooth-walled tube of one calibre throughout, but to present valvular infoldings of the mucous and muscular coats, and to vary in calibre at different levels. These valves may be transverse or spiral. In normal development the valves become flattened out, and the calibre of the ureter becomes more or less uniform, though four narrow portions remain where stones are likely to become impacted: first at the pelvic entrance, secondly an inch lower down, thirdly at the pelvic brim, fourthly at the entrance to the bladder. In this way we can understand how by failure of full development strictures, valves, kinks, and twists of the ureter may arise, and lead to unilateral hydronephrosis.

Abnormalities of the Kidney and Ureter.

Abnormalities may be of the kidney, pelvis, ureter or blood-vessels, either alone or in any combination. Those of the kidney are of position, form or number.

1. Defects of Position.

The kidney may lie anywhere along a line which runs from the second sacral vertebra across the iliac arteries to end at the normal position of the kidneys in the loin. Such displaced kidneys may be unduly mobile or be more or less fixed. The lower down they lie the more likely they are to be fused, and abnormalities of the vessels and ureters are common. The supra-renal gland bears no relation to such displaced kidneys.

2. Defects of Form.

The kidneys may be abnormally small or large, size variations. Atrophy is very often acquired, and due to an attack of nephritis (or less commonly calculus or embolus) in early life; if it is congenital other defects will usually be present, and the remnant will not show microscopical evidence of interstitial nephritis, but consist of relics of tubules and glomeruli, or possibly cysts. Very large kidneys may be hypertrophied solitary kidneys or fused solitary kidneys, in which case the two portions may be separated by a groove, show lobulation, hour-glass constriction or double ureter.

[1] Faxton Gardner, 'Annals of Surgery,' 1908.

The kidneys may be fused, forming horse-shoe, sigmoid and discoidal kidneys, when the blood-vessels will be abnormal, and the ureters will nearly always run ventrally across the front of the kidney (Fig. 7).

3. Defects of Number.

Absence of both kidneys may occur in monsters born dead, and has been described in one case in a girl who lived till the age of fourteen (Moulon, 'Arch. Gen. de Med.,' xvii, p. 424, quoted by Morris). Supernumerary kidneys are very rare, but it has already been shown how two kidneys may develop on one side giving rise to the presence of three kidneys.

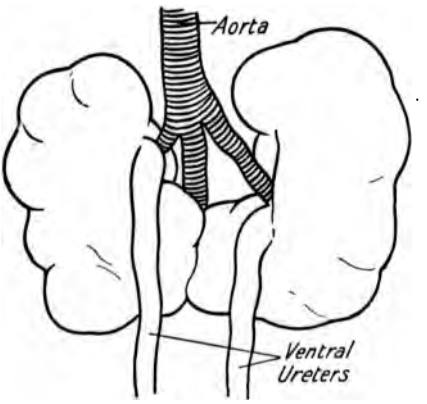


Fig. 7.—Horse-shoe kidney with ventral ureters lying on sacral promontory.

A solitary kidney is less rare, and Morris states that it should occur once in 2400 autopsies, though apparent solitariness of the kidney due to complete atrophy of the other is still more common. A solitary kidney may be an asymmetrical kidney, the bud of the other having failed to appear, and is then usually a large kidney from hypertrophy, or it may be a solitary fused kidney representing both renal buds, "horse-shoe," "sigmoid," "discoid," bifid or quadrate, and may possess one, two, three or four ureters.

The ureters will usually show an attachment into one side of the bladder only, but occasionally a single kidney may give rise to two ureters which obtain a perfectly normal attachment into the bladder, as in a case dissected in the post-mortem room at the London Hospital (see Fig. 8).

Ureteric meatoscopy therefore is not a sufficient guide

to the presence of two kidneys. Only X-ray examination with an iron oxide bougie in the ureters would have enabled this condition to be correctly diagnosed.

Certain rules may be formulated which will be found to hold in most cases.

1. In kidneys congenitally displaced the hilum tends to point forwards and the ureter to lie ventral to the kidney.

2. Fused kidneys tend to lie low down near the sacrum, near to or in the middle line.

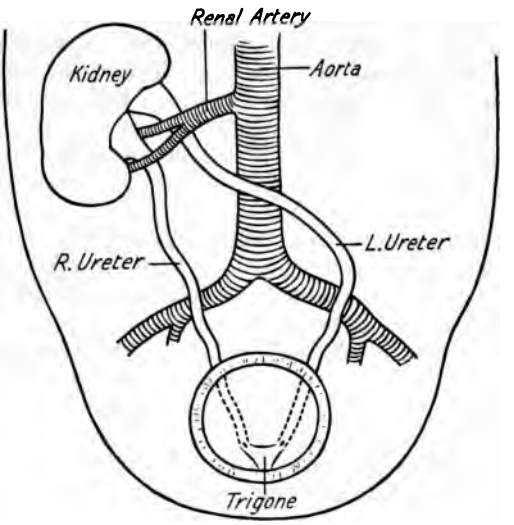


FIG. 8.—Solitary kidney, with double ureters, normally attached to the bladder. Autopsy specimen dissected and drawn by F. S. Kidd.

3. When two ureters are present the inner ureter passes to the upper part of the kidney.

4. Fœtal lobulation persisting means either congenital defect or long-standing back-pressure.

5. The presence of two normally placed ureters as seen by the cystoscope is no guarantee that two kidneys are present.

6. If any congenital defect be noted, the surgeon should be on the alert for others.

Symptoms and Diagnosis.

Symptoms are absent in the ordinary course of events, except in the case of horse-shoe kidneys, which lie on the sacral promontory, and not only may be mistaken for patho-

logical tumours, but may cause trouble during parturition. Calculus formation is extremely common in defective kidneys, possibly as a result of congenital metabolic defect (*cf.* cystinuria, alkaptonuria). If there is associated congenital obstruction to the ureter symptoms and signs of hydronephrosis will appear sooner or later, and, in fact, all cases of unilateral hydronephrosis should be suspected as instances of congenital defect unless the contrary can be proved. Associated deformities of the genitalia and of other organs are very common and should put the surgeon on the look-out for kidney defects. The cystoscope, the ureteric catheter, and injection of solutions opaque to the X rays, and the ureteric iron-oxide bougie combined with X-ray examination, have put fresh weapons into the hand of the surgeon by which he may make sure of renal and ureteric defect.

Congenital pouchings of the bladder may be seen, and the presence of a single or of three ureters be noted, or of two ureters abnormally attached. Congenital stricture of the lower end of the ureter leads to prolapse of the ureteric mouth, giving a characteristic cystoscopic appearance. The ureters can be sounded by catheters and bougies, the urine separated and examined, the presence of strictures, valves, and other obstructions, and of dilated pelvis made certain. Opaque solutions can be injected and opaque bougies passed, when X-ray examination will show accurately the course and number of the ureters.

Finally, in cases of doubt bilateral lumbar exploration may be required to decide the question as to the presence of two kidneys.

CHAPTER III.

INJURIES OF THE KIDNEY.

1. Subcutaneous. Without External Wound.
2. With External Wound.

I. Subcutaneous Injuries.

Ætiology.

Out of 153 cases of injury to the kidney, 118 were subcutaneous. Many authors state that these injuries are uncommon, basing their statement upon autopsy records, but if the clinical records of a large general hospital are taken it appears that they are amongst the most common of visceral injuries, and that recovery is the rule in uncomplicated cases. Küster in 306 cases found 281 in males (94 per cent.), 18 in females (6 per cent.). Ruptured kidney is uncommon in females because they are less exposed to severe injuries, and, as some hold, because of the greater mobility of the kidney in females.

Forces at work.—It is surprising how slight an injury may give rise to a ruptured kidney, so that for all abdominal injuries, however slight, the rule holds to put the patient to bed, then to examine him thoroughly, and to watch him closely for forty-eight hours at least.

Injuries may be direct, as in "run over" or "buffer" injuries, or in "falls" on to the side, or be indirect as in falls from a height on to the feet, sudden flexions of the trunk and so forth.

In life the kidney exists as a tense shell surrounding and containing fluid under tension, as pointed out by Küster. A blow on the surface sets up a bursting force in the fluid, and the shell gives way along lines radiating from the hilum to the convex border, chiefly in the central transverse axis of the organ. The condition may be compared to the bursting of the base of the skull along the middle fossa when a force is applied to the vertex.

Pathology.

CLASSIFICATION.

1. *Tears of the fatty capsule.*
2. *Localised sub-capsular hæmorrhage.*
3. *Tears of the parenchyma.*
4. *Tears of the parenchyma and pelvis.*
5. *Pulping.*
6. *Tears of the hilum.*
7. *Rupture of the peritoneum.*

Tears of the fatty capsule alone are not commonly recognised. They lead to an extravasation of blood within the perinephric fascia, but *not to hæmaturia,* the blood becoming absorbed, organised, infected, or forming a blood-cyst.

Localised sub-capsular hæmorrhages are probably of common occurrence, but are seldom revealed to the eye, pain being the only symptom, absorption the rule, suppuration the exception.

The distinction between tears of the parenchyma *alone* and of the parenchyma and pelvis *together* is largely academical, save that the latter yield more severe manifestations. In both the tears radiate from the hilum to the cortex, the true capsule is always torn, the extent of the injury is greater on the posterior surface, and there is an extensive retro-peritoneal extravasation of blood, which is limited by the perinephric fascia above and on either side, but below is free to extend into the iliac fossa and pelvis and come through the abdominal rings into the thigh and scrotum. Urine may be present in the extravasation, whether the pelvis is torn or not, but not uncommonly it is absent. The old idea that mechanical blocking of the tubules by blood-clot prevents the extravasation of urine seems hardly sufficient; more probably the damaged kidney is knocked out for the time being and fails to secrete any urine at all. The bleeding may prove fatal or cease spontaneously, and the blood-clot may be absorbed, organised, infected, or form a cyst.

The kidney may be pulped or torn to ribbons, causing fatal hæmorrhage unless an operation be performed.

In tears of the hilum the *blood-vessels* may be torn. *Incomplete* division causes very severe hæmorrhage at the time, followed if recovery ensue by thrombosis, and rarely by the formation of a traumatic aneurysm. If infection of the clot occurs secondary hæmorrhage is likely to arise and prove fatal. *Complete* division may cause little trouble from hæmorrhage, as the coats of the vessels can retract and contract, and the bleeding cease spontaneously, but infarction or com-

plete necrosis of the kidney follows as a matter of course, and infection is likely to occur leading to moist septic gangrene.

The ureter may be torn partly or completely across, giving rise to extravasation of blood and urine. If healing occurs a stricture tends to form, and in this way a "traumatic hydronephrosis" may arise. The same condition may be brought about if the ureter be incompletely blocked with organised blood-clot, be pressed upon by adhesions, or kinked from displacement of the kidney.

Extensive rupture of the peritoneum in adults is not a common complication (14 out of 251 Küster, 17 out of 254 Quervain quoted by Desnos), but it is common in children. It is a very fatal complication, either from hæmorrhage, which is profuse, or from diffuse peritonitis, and from the fact that it is usually complicated by injuries to other viscera. At the same time it is certain that extravasation of blood and urine into the peritoneal cavity is not invariably fatal, but that a localising peritonitis may arise in response to the injury to seal off the rupture, and the extravasated fluids be absorbed, though this consideration in no way diminishes the necessity for early diagnosis and early operation.

In natural repair of the torn kidney the blood-clot lying between the torn portions is removed by phagocytes, and replaced by fibroblasts and fibrillar connective tissue with the formation of permanent scars.

Complications.—Though the kidney is very commonly alone affected, yet in the more severe injuries other parts are likely to be wounded. Most often some of the lower ribs are fractured, and the liver, spleen, intestine, opposite kidney, bladder, and other viscera may be torn.

Morbid physiology.—Inhibition of secretion occurs in nearly every case, not only in the affected kidney, but also in the kidney of the opposite side. Perhaps only four or five ounces of urine are excreted in the twenty-four hours, and this condition of oliguria may persist, not only for days, but even for two or three weeks, without any "uræmic" signs appearing, and may explain the common absence of urine in the extravasated fluid. In cases that heal spontaneously the daily amount of urine gradually returns to the normal, sometimes followed by a period of polyuria with a second return to the normal.

If the injury be so severe that immediate nephrectomy has to be performed, it is found that the single remaining kidney is quite capable at once of taking on the same amount of

work as was previously performed by both kidneys, showing that physiological "compensation" can occur long before anatomical "hypertrophy," and suggesting one line of fallacy in all functional tests.

A case is reported by Dodds Parker, Poulton and Hunt ('Lancet,' February 6th, 1909, pp. 386–388), in which complete analyses of the urine were made over a period of three weeks in such a case. The volume of urine fell to a low value on the fourth day (about half the normal), but the total nitrogen excreted was well up to the normal from the first day onwards. Until the fourth day no chlorides were present in the urine, a fact which the authors explain as a result of excessive hæmorrhage before the operation and subsequent need for retention of chlorides.

Symptoms and Signs.

General Symptoms and Signs.

1. *Early.*—*Severe shock* is the rule, but exceptionally a man who has ruptured one kidney may go on with his work as though nothing had happened until the presence of blood in his urine frightens him and causes him to seek advice. If shock is present the patient experiences severe pain, which induces vomiting; he feels giddy and faint, grows pale and cyanosed, and breaks out into a cold sweat. The pulse is slow and feeble, the respiration shallow, and the temperature subnormal. Shock passes off in a few hours, and is succeeded by a period of reaction; the body grows warmer, the pulse improves, and the pain and vomiting are eased. If hæmorrhage continues "*collapse*" sets in, the lips are *blanched,* the patient is quite conscious but anxious, restless, and thirsty, and sighs repeatedly; the pulse beats faster and faster (120–130), and grows *feeble, soft, and empty*—signs which demand an instant operation.

2. *Late.*—If the hæmorrhage ceases spontaneously recovery may take place without more ado; but in many cases a troublesome condition of meteorism or ileus appears, which may baffle all attempts to control it for some days, and even prove fatal. The condition appears to be produced by the irritating effect of the retro-peritoneal extravasation on the sympathetic nerve-supply of the intestine.

If the peritoneum has been torn, and if the patient escapes the dangers of primary hæmorrhage, and of injuries to other

viscera, signs of peritonitis will appear after twenty-four hours or longer. The temperature rises to 102–103° F., the pulse is increased in rate (110–120), but remains of *good strength and tension.* Pain increases in intensity, becomes continuous, and the area of deep tenderness previously located in the loin becomes diffused over the whole belly, which is distended, fixed, and rigid. Vomiting comes on again, oft repeated, effortless, in small amounts, biliary at first, but later resembling coffee-grounds. Nowadays an operation should be performed before these signs have time to appear, as the early signs of intra-peritoneal hæmorrhage are an adequate indication for exploratory laparotomy.

Local Symptoms and Signs.

Pain.—Severe and continuous pain is experienced in the region of the kidneys, and is often accompanied by clot-colic, and by intense bladder-spasm as the clots are forced through the deep urethra.

Blood is *the* sign, and may appear in three directions:

1. In the urine stream.
2. In the retro-peritoneal tissues.
3. In the peritoneum.

Hæmaturia is the most constant sign and is hardly ever absent. The blood is bright red, diffused throughout the urine, and clots readily. The bleeding may be profuse, and prove rapidly fatal, or slight, but then may last for several weeks, and gradually drain away the patient's strength in the absence of timely surgical interference. In average cases it is moderate in quantity, and lasts for from two to seven days, and then clears up entirely.

Hæmaturia may occur:

1. *Without loin tumour,* in which case recovery is always rapid and complete.
2. *With loin tumour,* in which case recovery may be delayed, and may not occur without an operation.
3. *With signs of free fluid in the peritoneum,* in which case immediate operation is called for, and the condition is likely to prove fatal.

Abdominal examination.—(*a*) *Early signs* are localised deep tenderness over the back and front of the loin and lower ribs, accompanied by local rigidity of the abdominal musculature. Free fluid in the peritoneum is a sign that the peritoneum is torn, but as already stated this complication

is not common. In all cases the liver dulness should be accurately marked out at the first examination with a blue pencil, and the maximum circumference of the belly measured and noted for comparison with similar observations to be made at every subsequent examination.

(*b*) *Later signs* are those of extravasation of fluid into the retro-peritoneal tissues, the earliest evidence of which is the presence of dulness in the flank continuous with the dulness beneath the erector spinæ and extending towards the mid-axillary line, a dulness which cannot be made to shift by turning the patient on to the opposite side. As soon as the rigid muscles permit it, tactful palpation will reveal a large swelling lying in the back of the loin, much larger than a normal kidney, and that *does not move with respiration*, with colonic resonance in front of it, but dulness behind. This swelling consists of fluid lying between the two leaves of the perinephric fascia, which in neglected cases may extend downwards into the iliac fossa and appear as a deep blue extravasation beneath the skin over the inguinal and femoral rings.

Other urinary changes.—Increased frequency of micturition and urgent micturition are often associated with the hæmaturia. Oliguria is the rule, sometimes from the first, sometimes not for several days, and persists for days or weeks. Suppression of urine occurs only when the other kidney is diseased, or when no other kidney exists. Blood casts are found, and when all bleeding has ceased a trace of albumen may persist in the urine for a few weeks. If albuminuria is more marked and persistent, if casts are constantly found, and if œdema and the other signs of nephritis appear, this is evidence of a pre-existing latent chronic nephritis which has been raised out of the symptomless stage by the injury. Such a condition has been named "Traumatic nephritis," and the same name has also been applied to a "microbic nephritis" set up by secondary infection of the damaged tissues.

Course, Dangers, Complications.

In the usual course of events the bleeding ceases spontaneously, and the general condition improves rapidly in from two to seven days, the loin tumour gradually melts away in a few weeks, and the patient is restored to complete health. Not infrequently distressing meteorism gives trouble during the first week and may become a cause of anxiety, though it yields to active treatment.

Dangers and Complications.

After the first *shock* is over, *collapse from persistent hæmorrhage* is the first danger signal, the second being *extravasation into the peritoneum.* From the third day and onward *signs of infection* may appear, rarely of the peritoneum, more often of the retroperitoneal extravasation and of the kidney itself, the organisms reaching the spot either from the blood-stream direct or from the distended and thinned wall of the adjacent bowel (meteorism). The signs are those of general toxæmia and local suppuration.

Late complications are, on the side of the *renal vein,* embolism and pyæmia; on the side of the *renal arteries,* infection of the blood-clot, secondary hæmorrhage, and traumatic or false aneurysm; on the side of *the ureter,* partial occlusion by blood-clot, stricture, adhesions, kinks, leading to hydronephrosis; on the part of the *renal parenchyma,* infection, calculus formation round blood-clot or from infection, nephritis, uræmia, and suppression, but all these are uncommon.

Death arises from hæmorrhage, primary and secondary, or from rupture of a traumatic aneurysm, from infection and sapræmia, or from suppression and uræmia.

Diagnosis.

All patients with a history of abdominal injury, however slight, should be placed at once on their backs in a warm bed, and *then* submitted to a rapid but *complete* examination, beginning with a consideration of the general state of the patient. If error is to be avoided, *the first step* should be a consideration of the general state by means of examination of the pulse, respiration, temperature, nervous system, and skin for evidences of shock and collapse; the next step is a systematic examination of the abdomen; and lastly the urine should be tested. The use of any drug should be avoided if possible until after the first examination.

The practitioner should not be deterred by alarm for the life of the patient from making a complete examination of the chest and abdomen, which should be purposive and speedy, but never hasty or perfunctory, remembering that in all cases where treatment can be of avail the patient has always some hours to live, that nothing can avail for those severe cases that die a few minutes after they are first seen, and that the

patient runs greater risks if signs are missed by a careless examination than he does from the length and manipulation of a complete examination. Areas of deep tenderness and rigidity are recorded, and a special look-out kept for areas of abnormal dulness. If dulness is present in either flank it is of the utmost importance to decide definitely as to whether it is fixed or shifting. The liver-dulness is marked out with a blue pencil, and the circumference of the belly measured. If the patient is unable to micturate, and there be *no bleeding from the urethra,* a No. 10 (English scale) black gum elastic catheter should be passed and the amount and quality of the urine noted.

If hæmaturia is absent there can only be a hæmorrhage subcapsular or into the retro-peritoneal fat, neither condition of serious import, the diagnosis of the latter condition only being possible from the presence of a retro-peritoneal swelling.

If hæmaturia is present it is certain that there is a definite injury to the urogenital tract, and all that remains is to determine the source of the bleeding and consider the question of any previous disease of the kidney.

1. The Source of the Bleeding.

Urethral bleeding is at once made plain, the blood issuing from the meatus apart from micturition. Traumatic rupture of the bladder seldom occurs apart from crush fractures of the bony pelvis, and the history of the injury, the position of the bruising and scraping of the skin and of the pain, rigidity, and tenderness, seldom fail to indicate at once that the damage is to the bladder or kidney. *In doubtful cases* help may be gained by the catheter and the cystoscope. If the bladder cannot be washed clear the bleeding is certainly vesical; if it can be washed clear the cystoscope is passed, and blood will then be seen issuing from one ureter. It is as well to defer cystoscopy until the patient has been anæsthetised and everything prepared for an operation if found necessary.

2. Is there any Previous Disease of the Kidney?

If the nature of the injury be very slight, and there be no serious symptoms of shock, it is well to remember that underlying the bleeding in middle-aged persons may be a neoplasm of the kidney or a calculus.

3. Is the Peritoneum Torn?

The importance of deciding this question lies in the fact that if the peritoneum is torn nothing but an operation in the first few hours is likely to save the patient's life.

The presence of free fluid within the peritoneal cavity is the only certain sign, and the general symptoms of shock and collapse are far more severe than in extra-peritoneal rupture.

In cases where there is the slightest doubt an early exploration during the first six hours gives the patient his best chance. A median incision an inch long two inches above the pubes reveals the presence or absence of free fluid; if absent the incision can be closed at once and no harm has been done; if present suitable incisions can be made to find the cause of the trouble, and the median incision used for a pelvic drainage-tube. A look-out is kept for injuries to the other viscera.

4. Is the Hæmorrhage Continuing and Becoming Dangerous?

If the pulse is feeble, soft, and empty, and the rate is rising to 120–130, and at the same time the patient is becoming blanched, restless, and thirsty, such signs are evidence that the time has come for immediate operation to control continued hæmorrhage.

5. The Onset of Suppuration is suggested by a sustained rise of temperature after two or three days accompanied by other signs of sapræmia, and increase in the size and tenderness of the loin tumour.

Prognosis.

In uncomplicated cases the outlook is very hopeful. Wagner states that 70 per cent. heal under expectant treatment alone. Küster gives 222 simple cases with a 38 per cent. mortality, 84 complicated cases with a 92 per cent. mortality, 5 dying of shock, 30 of bleeding, 27 of suppuration, and 3 of chronic nephritis. With careful watching from hour to hour, and consequent more accurate diagnosis, with earlier operation if bleeding, peritoneal rupture, or suppuration be *but suspected*, the mortality should be considerably diminished in the future.

Treatment.

Expectant treatment gives brilliant results, and operation is the exception; yet the surgeon should not hesitate to explore if he is in the slightest doubt as to the safety of temporising, as only in this way can more perfect results be obtained.

1. Expectant.

The patient is put to bed in warm blankets, and the foot of the bed slightly raised on blocks for a few hours. The use of fluids or food, and, if possible, drugs, is avoided for some hours, and the patient is watched from hour to hour, and, if very restless, his knees should be tied together, with a pad placed between and a bolster beneath them.

Shock tends to pass off spontaneously after a few hours, but if severe and persistent it must be combated by bandaging the limbs and abdomen, and by the subcutaneous injection of ernutin (5 minims) hourly for four doses, or by nerve-blocking—*e.g.* by means of a large dose of morphia (gr. $\frac{1}{4}$–$\frac{1}{2}$).

Bleeding will often cease spontaneously, but in bad cases it will be wiser to explore and tie the bleeding point rather than trust to such doubtful remedies as Leiter's tubes, morphia, ergot, and calcium lactate. In cases where bleeding is slight but persistent, relief may be obtained by the exhibition of such drugs as dilute sulphuric acid (♏x–xv *t.d.s.*), turpentine (♏x *t.d.s.*) suspended in Tr. quillaiæ (♏x to the ounce of water), or gallic acid; but if it lasts for more than a week an operation is required.

The impaction of clots in bladder or ureter may necessitate surgical manipulations, clots in the bladder being broken up by a lithrotrite and evacuated with Bigelow's evacuator.

In cases that proceed favourably bed is maintained for at least fourteen days after all bleeding has ceased. The diet should be of milk at first, but can early be replaced by a diet moderate in proteid and purin content. If vomiting persist and prove obstinate rectal feeding may be needed for a day or two. Urotropine (in five-grain doses) should be given as a routine with the idea of warding off infection of the extravasated fluids.

2. Operative Treatment.

Indications.

A. *Early.*

1. *Hæmorrhage.*
   - *a.* Early, profuse, extra- or intra-peritoneal.
   - *b.* Persistent small amounts lasting for more than seven days.
   - *c.* Persistent clot colic.

2. *Free fluid in the peritoneum.*
3. *If there is any doubt as to whether the peritoneum is torn or hæmorrhage becoming dangerous.*

B. *Remote.*

1. *Suppuration.*
   a. Retroperitoneal.
   b. Peritoneal.
2. *Blood-cyst or persistent extravasation.*
3. *Secondary hæmorrhage.*
4. *Aneurysm.*
5. *Calculus.*

Operation.

Spinal anæsthesia is probably the best method to employ, as it removes all fear of further shock, but if a general anæsthetic be employed it is best to use ether. It is as well to pass a cystoscope and note the presence of two ureters. The lumbar route is chosen if the peritoneum is thought to be free, the kidney being thoroughly exposed and the pedicle temporarily secured by the fingers, which permits inspection of the amount of damage done. If the main arteries are torn across, or if the kidney is torn to shreds, nephrectomy will be rendered necessary, but the surgeon should be loth to carry out nephrectomy when it is found that the tears tend to radiate from the hilum to the convexity just in the lines of the main vessels, as repair can often be effected and hæmorrhage staunched by inserting mattress-sutures of stout catgut through and through the kidney substance, with a bight of at least an inch, and knotting them firmly, but not so as to strangulate the vessels; or a network may be made of strands of catgut and the kidney held together within it. Gauze packing is sometimes of great help, especially if the gauze be soaked in a weak solution of adrenalin (1 : 50,000). The blood-clot is sponged out from the recesses of the wound, the peritoneum examined for tears, drainage provided by means of a large rubber tube, the rest of the wound stitched up, and the patient put back to bed, the foot end of which is elevated for seven days.

If the peritoneum be found torn an exploration can be made of the adjacent viscera, the peritoneum cleaned with dry sponges on holders and the rent stitched up completely.

If the peritoneum is known to be torn before operating it is better to enter the peritoneum from in front through the linea

semilunaris, to sponge out the blood and attend to the other viscera. If nephrectomy is indicated it can be carried out forthwith, a tube inserted posteriorly by a stab wound through the skin and muscles behind, and the peritoneum stitched up; but if the kidney is retained drainage should still be by a posterior stab wound, and the peritoneum stitched up completely. Peritonitis will not ensue if the blood and urine are simply sponged out, but there is no harm in washing them away with salt solution, after which the rent is repaired.

Ileus is best treated by repeated doses of calomel (gr. j hourly for twelve hours) and repeated enemata of soap and water, brine, or alum. Turpentine had best be avoided. We have also had good results with the subcutaneous injection of physostygmine sulphate gr. $\frac{1}{100}$ every four hours for four doses, and strychnine should be given to the limit of tolerance.

2. With External Wound.

Such wounds are uncommon except in war.

CLASSIFICATION.

A. *Without prolapse.*
   1. *Punctured* (stab, lance, bayonet, etc.).
   2. *Bullet* { Military (high velocity). / Civil (low velocity). }
   3. *Lacerated wounds* (shell).

B. *With prolapse.*
   1. *Lacerated wounds* (shell or machinery).

Sequelæ.

In the absence of bacteria, or extensive "laceration-necrosis," healing readily occurs by the organisation of blood-clot. Laceration predisposes to attack by bacteria, which are either carried in on the weapon or may reach the part later through the blood. Infection leads to suppuration, which may become localised as an abscess or fistula, or may lead to pyelonephritis and all its complications, and also to secondary hæmorrhage. Incomplete division of the wall of a large artery will lead either to fatal primary hæmorrhage or to healing by organisation of blood-clot and formation of a traumatic aneurysm.

Complete division will cause necrosis of the portion of kidney supplied by the artery. These wounds are generally

complicated by wounds of neighbouring viscera, such as the gut, liver, spleen, and lung.

Symptoms and Signs.

The early general symptoms are those of shock and collapse from hæmorrhage, but later those of septic absorption, fistula, or aneurysm. Hæmaturia is the rule, but may be absent. Definite urinary fistula and prolapse of the kidney are very uncommon.

Diagnosis and Treatment.

All punctured wounds in the region of the kidney must be considered as potentially infected, with the exception of bullet-wounds caused by the modern high velocity rifle (see below). If they can be rendered more or less sterile healing will be rapid and complete, unless the vitality of the soft parts has been lowered by extensive bruising. The dangers of leaving such a wound alone far outweigh the dangers of immediate exploration. The treatment is therefore used in making the diagnosis. No attempt at probing the wound should be made until the surgeon is prepared to operate under a general anæsthetic. A general anæsthetic is administered as soon as possible, using stovaine spinal anæsthesia if there is much shock, or a preliminary large dose of morphia ("nerve-blocking").

The wound is lightly plugged and the skin disinfected, after which the plug is removed and a probe passed into the wound. A large exploratory incised wound is made, the cut being planned so as to surround and excise the punctured track as far as possible, and the incision being deepened till the limits of the track have been reached, and the diagnosis of wounded kidney made in this manner. The kidney is thoroughly explored and its condition examined after hæmorrhage has been controlled, foreign bodies and lacerated and bruised portions of tissue being removed, and the wound thoroughly sponged out for some minutes with hot aqueous carbolic acid (1 : 20) brought into close contact with the soiled portions of the wound. If the pelvis and ureter are cut they should be repaired with a single layer of fine catgut sutures. Partial nephrectomy should be practised on any portion of the kidney deprived of its arterial supply or extensively lacerated and bruised. If the renal artery is completely

divided nephrectomy is the better course, but if incompletely an attempt should be made to repair the rent, using the finest round needles and the finest silk boiled in vaseline, and taking care that the media and adventitia are not turned in between the two layers of intima. A large rubber drainage-tube is conducted from the kidney to the surface, and the remainder of the wound stitched up in layers and dressed with dry gauze.

The bullet of the modern rifle leaves the muzzle with such a high velocity that, not only is it sterilised in the process, but does not carry in particles of clothing with it, as was found by experience in the late wars. If death from primary hæmorrhage did not occur far better results were obtained by dressing the external wound or wounds with a sterilised pad and keeping the wounded soldier at rest on his back after reaching the hospital, and awaiting natural healing, than by attempts to explore the wound under the necessarily defective conditions for operation that obtain in war. Recoveries in such cases were surprisingly high (70–75 per cent.).

In civil practice bullets cannot be considered as sterile, and, owing to their lower velocity, carry in portions of clothing with them. Bullet-wounds in civil practice should therefore be treated in the way first described. The prognosis is good if asepsis can be obtained, and in the absence of other complications, such as aneurysm and wounds of other organs.

Aneurysm of the Renal Artery.

Henry Morris[1] could only collect nineteen cases from the literature up to 1900, so that the disease is very rare.

Renal aneurysms are:

1. *Traumatic or false.*
2. *Spontaneous or true.*

The traumatic are caused by the rupture or puncture of the wall of the renal artery, a sacculated aneurysm, or a diffuse aneurysmal hæmatoma resulting.

The spontaneous arise from diseases of the vessel-wall combined with a heightened blood-pressure, the causes being syphilis, infective emboli, and senile degeneration.

The cavity of the aneurysm contains laminated layers of blood-clot and communicates with the renal artery by an opening of varying shapes and sizes, the wall being formed by condensed layers of fibrillar tissue closely adherent to the

[1] 'Surgical Diseases of the Kidney and Ureter,' vol. i.

surrounding tissues. As the tumour increases in size it presses upon the surrounding organs, and either displaces them or causes pressure atrophy, finally bursting into some neighbouring cavity.

Clinically a traumatic aneurysm is ushered in by some injury to the kidney, which clears up for the time being, but a few months, or even years later an abdominal tumour is noticed, which may be painless and of slow growth, or may cause pressure symptoms on the nerves, blood-vessels, and organs in its neighbourhood. *Hæmaturia* may appear, either in small amounts frequently repeated, or so profuse as to fill the bladder with clots and rapidly cause death. Death may also occur from internal hæmorrhage into the peritoneum. The tumour is of large size, and lies just to one side of the middle line in the upper part of the abdomen, is firm, elastic, rounded, and painless, and is absolutely fixed to the posterior belly-wall. Pulsation is seldom felt, but when present it is expansile, and persists even when the patient lies prone. A systolic bruit has been heard over such a tumour, and the percussion note yields a dull tympany.

The diagnosis may be suggested by the history of a recent kidney injury, but it is impossible to be certain that the tumour is not a neoplasm. A neoplasm may come on after an injury, may pulsate and present a bruit, may lead to profuse painless hæmaturia, and, in fact, may simulate an aneurysm in every way. The diagnosis can only be made by open exploration, which should always be undertaken early in cases of injury when a loin-tumour persists for more than a month, or in cases where attacks of painless hæmaturia cannot be assigned to a general cause. On exposure of the tumour, if the diagnosis is not evident, incision will reveal laminated blood-clot. Henry Morris advises immediate plugging of this incision rather than further turning out of the clot, followed by nephrectomy by the lumbar, transperitoneal or combined routes.

The disease is inevitably fatal in from a few months up to five years, apart from operation.

CHAPTER IV.

NEPHROPTOSIS. MOVABLE KIDNEY.[1]

Definitions.

The kidney in health has a wide range of up-and-down movement during expiration and inspiration of at least one to one and a half inches, so that *all* kidneys are strictly "movable," the lower pole descending at the end of full inspiration to within one inch of the umbilical line on the right side, one and a half inches on the left side.[2] Many kidneys are placed lower in the abdomen, and have a wider range of movement without causing any symptoms; but undue mobility is a very common cause of symptoms. The difficulty of drawing a distinction clinically between normal mobility and undue mobility has led to wide variations in the figures given by different authors. "*Nephroptosis*" is the most correct name for pathological mobility, but the term "*Movable kidney*" can hardly be avoided, and has the merit of common use and convenience. "*Floating kidney*" is a term applied to those rare cases of congenital defect where the kidney has a mesonephron and floats freely in a complete double fold of peritoneum.

The Supports of the Kidney.

The weight of the kidney is supported *in health* by the general abdominal pressure. The abdominal viscera are contained in a closed bag surrounded by elastic muscular walls which by their tone maintain a condition of intra-abdominal pressure considerably above that of the outside air. As the

[1] For ideas and help in preparation of this chapter we are deeply indebted to Professor Keith. See Allbutt, 'System of Medicine,' new edition, vol. iii, 1907, p. 860. Keith, article on "Splanchnoptosis," bibliography.

[2] "The average height of the kidney above the umbilical line is 30 mm. on the right side, 35 mm. on the left."—Keith.

diaphragm descends during inspiration, the supra-umbilical viscera are forced downwards and forwards, the thrust being resisted by the active tonic contraction of the muscles of the belly wall obliques, transversales, and recti, which *do not completely relax during inspiration.* During expiration the diaphragm relaxes, and is driven upwards through and with the viscera by means of the active contractions of the muscles of the belly wall, movements which at the same time drive the venous blood on into the heart and prevent stagnation of blood in the abdominal viscera. The peritoneal attachments and ligaments do not *support the weight* of the viscera *in health,* but their function is to carry the blood-vessels and nerves to the different organs, and to *restrain and anchor* the viscera if exposed to unusual and excessive dislocating forces, so that they keep their relative positions. The peritoneum and its attachments are very elastic, and can be stretched as much as 2–4 inches in health (Keith).

If from any cause the muscles of the belly wall fail to support the weight of the viscera the peritoneal ligaments have to take on a supporting function, but they become gently stretched in the process, the viscera prolapse, and their vessels and nerves are pulled upon and interfered with. The peritoneal attachments therefore only *support the weight* of the viscera *in disease.*

The kidney is *restrained* from moving inwards and forwards by the attachments of the peritoneum as it sweeps over the kidney and colon, and by the perinephric fascia. *The perinephric fascia* is fixed to the back of the belly wall above and *does not move during respiration.* It splits into two layers which enclose the supra-renal completely above and below, so that this body does not move down within it. Extremely delicate elastic bands of connective tissue run from its inner surface to be attached to the true fibrous kidney capsule. *In health* these do not take the weight of the kidney, though they may do so *in disease* and *after operations* on the kidney, when they are turned into tough scar-tissue. *The perinephric fat* lies interspersed amongst these bundles between the perinephric fascia and the kidney, and serves to transmit the abdominal pressure to the walls of the kidneys, prevents jarring, lubricates the kidney movements, and adapts the perinephric space to the movements of the kidney within the perinephric fascia. It is said to be absent in children before the age of ten, but this statement is founded on the examination of wasted children in the post-mortem room.

Summary:

In health the moving kidney is supported by the general abdominal pressure, and is restrained from any excessive dislocating forces by the attachments of the perinephric fascia and peritoneum.

In disease, if the support of the abdominal muscles is removed the moving kidney has to fall back upon the attachments of the perinephric fibrillæ, the perinephric fascia and peritoneum, and upon its pedicle, which soon become stretched to an excessive degree, the result being excessive mobility.

If the abdominal muscles are healthy and retain their tone, dislocation of the kidney may still be produced either by sudden rupture of the perinephric fascia and peritoneum, or by the kidney being crowded out or squeezed out of the supra-umbilical space. When none of these causes are at work the movable kidney must be considered as ectopic or mal-developed. Either it has never ascended to its proper level during fœtal life, or has descended again during the development of the trunk from the infantile to the adult type.

Thus there are two distinct groups of cases which present movable kidneys. In one the kidney is *ectopic,* just like an undescended testicle, and has failed to ascend or maintain its proper position in the loin in the course of development. In the other the kidney is *prolapsed.* It has developed normally and reached its proper position in the loin, but from certain acquired causes it has dropped again. The two conditions may be distinguished as *Ectopia* and *Nephroptosis.* One is *congenital* or *germinal,* the other is *acquired.*

The Congenital Group. Ectopic Kidney.

Man, in evolution from the quadruped, has assumed the upright position, and to maintain this without visceroptosis, and without a fatal fall in systemic and cerebral blood-pressure from stagnation of blood in the splanchnic vessels he has had to develop two important muscle-nerve systems. In the first place a vaso-motor apparatus which responds to a rise into the upright position by vaso-constriction of the splanchnic arteries, in the second place a viscero-motor apparatus controlled by sympathetic impulses from the viscera, which produces a tonic contraction of the abdominal musculature, so as not only to prevent the viscera from pro-

ORIGINAL

lapsing but also to keep the splanchnic veins from becoming gorged with blood, since the splanchnic veins if unsupported can hold all the blood of the body. There is therefore a correlated progressive evolution of the abdominal sympathetic nervous system and of the musculature of the belly wall and splanchnic arteries.

Such an hypothesis would explain why splanchnoptosis and neurasthenia so often appear together, muscle wall and nervous system either failing together to attain full development or being knocked out by the same causes of stress acting through and on the nervous system.

And in this way could be understood one of the types of cases met with in males as well as in females. The type is small and thin, has a long, flat phthinoid chest, with undue obliquity of the lower ribs and narrow subcostal angle. The spine has a poor lumbar curve, the sacrum is perpendicular, and the renal fossa shallow, wide, and vertical. The waist is small, the arms are long, and the muscles everywhere thin. The sympathetic nervous system is defective, exhibiting either great instability or a lowered power of resistance to stimuli. There is partial or complete splanchnoptosis, both kidneys, and especially the right, being markedly displaced. Associated minor defects are often present—for instance, in males of this type hypospadias and para-urethral follicles may be seen; and abnormalities of the arteries and ureters are discovered at operation.

The Development of the Metanephric Kidney.

The human kidney is developed *in the pelvis* from the metanephros. In the healthy fœtus the metanephric kidney moves upwards from the pelvis, and undergoing a rotation, reaches the normal adult position in the loin (see Ch. II, Sect. I).

It may fail to reach this position and thus become *ectopic*, just as a testicle may fail to descend to the bottom of the scrotum. An ectopic kidney shows other evidence of congenital defect, such as blood-vessels of abnormal length, course or origin; kinks, folds, valves, twists and strictures of the ureter; double ureter, persistence of fœtal lobulation, horse-shoe kidney, etc.

An ectopic kidney may therefore occur alone, or in conjunction with other inherited defects, and especially with the regressive type described above, in regard to which a word of explanation must be added.

In this regressive type the kidney may appear to reach its proper position in early life, but as the body attains its full adult development, the chest becomes longer, narrower, and flatter, and all the viscera come to occupy a lower position, especially the kidney. The kidney becomes ectopic with the onset of puberty, and yet the change may be a true germinal variation. In other words, it is not at all necessary for "congenital ectopia" to be present in infancy, but it can appear in the soma at any time in the course of growth.

The Acquired Group. Nephroptosis.

The kidney may be the only organ showing prolapse, or it may be accompanied by prolapse of most or all of the other viscera.

Complete splanchnoptosis is due to loss of tone, wasting, and stretching in the musculature of the belly wall, especially the transversalis and recti muscles, the causes being incomplete involution after parturition, sudden removal of large abdominal swellings, and neurasthenia.

In partial ptosis the kidney is squeezed out of its corner in the supra-umbilical space either because that space is compressed from without by tight-lacing, or because its contents have grown too large for it to hold them all. On the right side the kidney is the first organ to yield to such forces, on the left side the stomach and transverse colon.

Harris[1] maintains that the essential cause lies in a particular body-form which he found to occur almost constantly in women with movable kidneys. In this form the middle zone of the trunk that lies between the xiphisternal and umbilical lines is diminished in capacity, just that zone which contains the supra-umbilical abdominal viscera. The right kidney is thus placed at a disadvantage and is bound to be squeezed out sooner or later by the constant minor traumas of ordinary life. He does not profess to account for the body-form. Under the hypotheses suggested above this form is either a defective process of growth or is induced by compression of the zone by tight-lacing and cough.

Summary of Causes.

I. Congenital Ectopia.

A. Ectopic Kidney, failure to ascend and present as a solitary defect.

[1] 'Journ. Amer. Med. Assoc.,' June 1st, 1901.

B. ECTOPIC KIDNEY, a part of a general defect of development of the whole body to adapt itself to the upright position, ascending fully during infancy, but descending again as adult growth is completed.

2. Acquired Ptosis.

A. PTOSIS OF THE RIGHT KIDNEY.

1. *Compression* of the lower ribs and hypochondria and enclosed supra-umbilical viscera by:
   - (*a*) Tight-lacing.
   - (*b*) Constant cough, and the action of the expiratory muscles on the lower ribs.
2. *Excessive increase in size of the supra-umbilical viscera,* so that one organ has to yield, *e. g.* morbus cordis (24·6 per cent.), large liver and heart.

B. PTOSIS OF SEVERAL OR ALL THE VISCERA. Splanchnoptosis (due to loss of tone in the belly musculature).

1. *Incomplete involution* after parturition.
2. *Neurasthenia* and loss of sympathetic tone.
3. *Sudden removal of any cause of chronic abdominal distension, e. g.* ascites, large tumours, etc.

Incidental Causes.

Severe trauma is said to be capable of producing a dislocation of the kidney by rupture of the perinephric fascia and peritoneum, the kidney being dislocated into the peritoneal cavity. Increase in size and weight from neoplasm or cyst are minor aggravating causes. The common age is from twenty to thirty-five, but it is often present in children without symptoms. It can occur in women who have never been pregnant, and also in races who do not adopt modern dress. For instance, Trekaki examined 100 Arab women and found 30 mild and 11 severe cases.

The condition is far more common on the right side than on the left in the proportion of at least fifteen to one. If it occurs on the left side by itself the condition is nearly always congenital. If it occurs as an acquired condition on the left side it is due to general splanchnoptosis, and the right side will nearly always be found more severely affected.

Hector Mackenzie, whose figures are among the most reliable yet published ('Lancet,' October 26th, 1907), defines a *movable kidney* as one in which he can get the fingers completely above the upper end of the kidney, a *palpable kidney* as one where he can feel a considerable part of the kidney,

and neglects the numerous cases where he can just feel the lower pole.

	Palpable.	Movable.
2801 females of all ages were examined	449 (16 %)	515 (18·4 %)
1067 males of all ages were examined	25 (2·3 %)	11 (1 %)
99 female children under 12 years	10	—
136 „ „ age 13–16 years	19	7
293 „ „ age 17–19 years	42	35

Of females between 23–29, 21·4 per cent. had movable kidneys. Of females between 30–37, 27 per cent. had movable kidneys.

(Glenard's figures are in close agreement: 2202 women showed 22 per cent. movable kidneys; 2013 men showed 2·7 per cent. movable kidneys.) Out of 526 cases of movable kidney in only 1 was it found on the left side alone, in 49 on both sides, 476 on the right side alone. 138 cases had morbus cordis, 34 showed movable kidney (24·6 per cent.); 602 cases had dyspepsia, 143 showed movable kidney (23·7 per cent.); 463 cases had pulmonary tubercle, 101 showed movable kidney (21·8 per cent.); 562 cases had bronchial catarrh, 91 showed movable kidney (16·2 per cent.). Mackenzie found that child-bearing has less influence than is generally thought. Of 515 well-marked cases 411 had no symptoms to be attributed to the kidney.

Pathological Anatomy.

In the majority of movable kidneys encountered at operation the perinephric fat is present in average quantity. The exposed surface is unduly pale and peppered over with white triangular flecks, evidence of slight fibrosis of the inter-lobular connective-tissue framework, the kidney and pelvis feel flabby, and the pelvis is hollowed out and boat-shaped—evidence of early intermittent back-pressure. The kidney may present various abnormalities, such as fœtal lobulation; vessels which come off from the aorta too low down, or are of abnormal length though attached normally, or are supernumerary and run an aberrant course to the poles of the kidney, perhaps looping behind and hooking up the ureter; the ureters also may be abnormal, supernumerary, kinked into an **S** the sides of the **S** being adherent to each other, twisted, strictured, the stricture being combined with an abnormal high opening into the pelvis, or possessing a valvular mouth (see Ch. I, Sect. II).

If the kidney be exposed from the front across the perito-

neum, as at autopsy, it will be found that the lower pole of the kidney traces a segment of a circle downwards, forwards and inwards round the vascular pedicle as the radius of the circle, the centre being the aortic attachment of the renal artery, and the lower pole comes forwards, usually on the inner side of the ascending colon carrying a sac of peritoneum with it, which forms a kind of reversed hernial sac of invaginated peritoneum.

Secondary conditions that may be met with are hydronephrosis, pyelo-nephritis, pyonephrosis and calculus.

Clinical Signs and Symptoms.

The condition may be symptomless and be discovered during a routine abdominal examination. For instance, in 515 well-marked cases Hector Mackenzie found no symptoms in 411 that he could attribute to the kidney. The onset of symptoms may be gradual, or may be produced suddenly by a violent effort or strain. Clinically there are four main groups:

1. The symptomless.
2. The renal.
3. The gastro-intestinal.
4. The neurasthenic.

The Renal.

Groups—1. Renal pain—dragging.
colic.
2. Renal pain combined with—
a. Albumen.
b. Albumen and casts.
c. Hæmaturia.
d. Hydronephrosis, transitory or permanent.
e. Pyelonephritis, pyonephrosis and calculus.

Pain is of two kinds, the renal drag and the renal crisis.

A. *The renal drag* is a dull continuous pain wearing to the patient, but not sufficient to prevent her getting about. It is described as a dragging pain in the loin, or as a sickening sensation of something moving. It comes on fitfully, especially when the patient is run down or at the menstrual period, and may be absent for weeks together. *It is only present when the patient is up and about, and is nearly always relieved entirely by a short stay in bed*—a very characteristic feature.

B. *The renal crisis (Dietl's crisis).*

The pain resembles renal colic in its position, character, and mode of spread, but is seldom quite so severe as that caused by a stone (see p. 82). It is brought on suddenly while the patient is up and about by some jolting movement, and is accompanied by severe vomiting and cold sweats. During the attack the kidney can be felt to be very tender and increased in volume, and the amount of urine passed is diminished to 10–20 oz. in the twenty-four hours. The urine may contain albumen and casts and rarely blood. After a short time, seldom longer than a few hours, the pain passes away suddenly, accompanied by polyuria and constant desire to micturate. The urine passed is very pale, of low specific gravity, and seldom contains any blood, even in microscopic amount, which may help to distinguish it from the colic of stone and neoplasm. The condition is rapidly relieved by rest in bed, with the foot end elevated on blocks, and has been explained in several ways:

1. That the ureter is twisted, giving rise to "intermittent hydronephrosis."
2. That the nerves of the pedicle are twisted, giving rise to a vaso-motor and secretory crisis.
3. That the veins are obstructed, giving rise to congestion and hæmaturia.

Frequency of micturition is increased during the period of polyuria.

Hæmaturia is produced by intermittent strangulation of the veins and arteries, or may be caused by the presence of stone, but it is uncommon as a symptom. It is sometimes present when there is an abnormal "tail" artery and vein to the lower pole looping beneath the ureter.

Pyuria is absent unless infection has occurred.

Gastro-intestinal Symptoms.

Attacks of nausea and copious biliary vomiting may accompany the severe renal crises, and after a time a condition of chronic atonic dyspepsia may ensue, marked by anorexia, pyrosis, flatulence, severe constipation, and occasional bouts of vomiting. These attacks are:

1. *Reflex* from the effects of the pain on the solar plexus.
2. Caused by *primary atonic dilatation of the stomach,* a part of the general neurasthenic state without pyloric obstruction.

3. Caused by *secondary dilatation of the stomach due to pyloric obstruction* from associated gastroptosis, or from kinking of the duodenum, directly produced by the kidney.

Jaundice is an occasional complication. It is produced by:

1. Associated cholecystitis with gall-stones.
2. Associated hepatoptosis with kinking of the common duct.
3. Duodenal catarrh spreading to the bile-duct caused by kinking of the third part of the duodenum.

It appears that the moving kidney cannot directly pull upon the bile-duct itself. Gall-stones are a very frequent concomitant of a right movable kidney.

Symptoms Referred to the Nervous System.

Patients with movable kidney may be divided into three groups:

1. Those in whom the *nervous system is healthy.*
2. Those in whom the constant pain of a movable kidney has induced a condition of nervous prostration—"*secondary neurasthenia.*"
3. Those in whom the *nervous system is primarily defective,* the neurasthenia is primary, or accompanies but overshadows the movable kidney, which merely seems to aggravate the neurasthenia already present.

Many neurasthenics appear to belong to a congenital defective type, and the prolapsed kidney is but a part in the general disorder, but undoubtedly severe neurasthenia can be induced by the constant troubles associated with a movable kidney, and can be cured by nephropexy if undertaken early enough, and in the absence of general visceroptosis, so that in considering the advisability of operation this point requires careful consideration in each case, namely, which is primary, the movable kidney or the neurasthenia?

The neurasthenic type associated with movable kidney is never free from pain somewhere—pain over the coccyx, pain in the middle of the back, and frontal headache being the three main situations, but pain may be felt almost anywhere, varying between a facial or intercostal "neuralgia," and pain in any of the viscera such as the kidney, ovary, or uterus.

The patient is irritable, restless, fearful, easily tired, of deficient will-power, and subject to great fits of depression, yet in periods of excitement capable of considerable effort.

Palpitations and flushings are common complaints, and the patient is often worn out by repeated pregnancies and the worries of married life, and suffers from splanchnoptosis, partial or complete.

Physical Signs.

General inspection may reveal a well-formed chest and spine, well-nourished skin, and well-braced musculature, but often the chest is long and flat with a narrow subcostal angle, the lumbar spine is straight, the waist narrow, the skin pigmented and atrophic, and the belly muscles flaccid and flabby.

Abdominal Examination.

In order to feel the kidneys a proper method of palpation must be learnt and practised assiduously. The patient lies on a firm, flat couch, with pillows under the head and shoulders, the legs not drawn up but flat. She is instructed to open her mouth, breathe gently in and out, and allow the belly wall to relax. The surgeon kneels on one knee by the couch *on the side to be examined,* and uses *a single hand for palpation,* the right for the right kidney, the left for the left. The thumb is placed underneath the back of the loin space, and the straightened fingers are then laid gently over the front of the loin above the umbilical line. When the patient has grown accustomed to the fingers, and has learnt to relax her muscles, the fingers are pressed gently inwards and upwards towards the thumb during each expiration. During inspiration the fingers maintain the ground gained, but neither relax nor increase their hold, and after three or four respiratory excursions it will be found that the fingers can feel the thumb through the quadratus muscle. So far no attempt has been made to feel the kidney, the object being merely to feel the loin space empty between the thumb and fingers.

"Catching the Kidney."

The patient is now instructed to take a deep inspiration, and as she does so the fingers relax, and permit the kidney to enter the space between them. The kidney is dimly felt at this stage, and efforts are now made to catch the kidney between the fingers and thumb by a quick, snapping move-

ment carried out just as inspiration ceases. With a little practice in this manœuvre the lower pole of the normal kidney on the right side can nearly always be felt, except in fat subjects. It is felt for a moment and then flies upwards out of reach, but when the kidney is unduly movable, the middle or even the upper pole can be grasped, and in severe cases the kidney can be held down during expiration, exhibiting little tendency to fly up out of reach. In such cases the kidney, when caught, can often be squeezed inwards and forwards round its pedicle towards the iliac fossa and upper part of the hypogastrium.

In cases of doubt the same method should be practised with the patient standing upright, as only in the upright position can the true lowest limit of ptosis be estimated.

The swelling should present all the characters of a renal tumour, smooth, rounded, kidney-shaped, felt behind in the loin as well as in front, with resonant gut in front of it, and dulness behind in the loin fusing with the erector spinæ dulness. The kidney may be of normal size or it may be enlarged from hypertrophy, hydronephrosis, pyelonephritis, pyonephrosis, cyst and new growth. Four degrees of mobility can be distinguished:

1. The lower pole can be felt, but escapes upwards during expiration. On the right side this must be considered as the normal, on the left side as abnormal.
2. The middle of the kidney can be caught, but the kidney escapes during expiration.
3. The finger can be got above the upper pole, in which event the kidney can always be held down during expiration.
4. The kidney is floating and can be pushed down into the iliac fossa and front of the sacral prominence, and even across the middle line.

To obtain an accurate measure of the level of the lower pole of the kidney the following horizontal lines should be mapped out from which to take measurements (Keith):

1. The sterno-ensiform line, drawn through the junction of the sternum with the ensiform cartilage.
2. The umbilical line, drawn through the umbilicus.

The average height of the kidney above the umbilical line is 30 mm. on the right side, 35 mm. on the left (Keith).

Visceroptosis.

This condition may co-exist and be partial or complete. In certain individuals the right kidney alone may be prolapsed,

but in more severe cases the stomach and colon follow. Later still the liver, the spleen, and the left kidney are all prolapsed, the muscles of the belly wall being atrophic, flabby, and pendulous, and to all this may be added prolapse of the pelvic viscera. In patients with complete prolapse severe neurasthenia is usually present, and the problem arises as to whether this is *primary* or is *secondary* to the flabby condition of the belly walls. The venous return from the veins of the abdomen is entirely dependent on the pumping action of the diaphragm and muscles of the belly walls, When these are impotent, as in visceroptosis, the circulation flags, the blood tends to stagnate in the veins of the abdomen, and the vessels of the nervous system and limbs suffer. Elastic support to the belly walls is the best remedy for this venous stagnation, and if it brings the nervous system back to comparative health it shows that the condition was secondary.

Changes in the Urine.

The daily amount should be measured, and during the "crises" oliguria will be noted, followed at the end of the attack by polyuria. The urine may be healthy; may be pale and of low specific gravity; may contain a trace of albumen and casts, and rarely blood. Pus is found only when definite bacterial infection has occurred.

A look-out should be kept by means of the cystoscope for abnormalities in the lower ends of the ureters, and ureteric catheterisation may reveal an obstruction in the upper end of the ureter, especially in congenital cases and cases marked by "crises," and yield a certain indication that operation is required and that the upper end of the ureter requires exploration.

Course, Duration, and Prognosis.

The course is marked by latent periods of uncertain length. Some patients only suffer pain when run down in health, and are quite free when "fit." Others suffer regularly at the menstrual periods, and in between are quite free from pain. The affective tone of the whole nervous system is lowered at the menstrual period, so that stimuli which usually pass unnoticed cause pain during this time, and the kidneys are flushed with blood.

When symptoms are once established they tend to persist

continually, unless treatment be adopted, and in a year or so gradually wear down the nervous system, producing severe neurasthenia. Even if neurasthenia is primary, treatment directed to keeping the kidney in its place may bring relief, even if it does not cure.

The prognosis is good after nephropexy in young persons otherwise in good health, with a widely wandering kidney as the sole lesion; when pain is readily relieved by recumbency; when the nervous system is healthy; and in the "gastro-intestinal" and "hydro-nephrosis" groups. Neurasthenia renders the effect of the operation doubtful, and if it has existed for more than a year almost hopeless, as do chronic incurable cough and morbus cordis. In splanchnoptosis the general health can be much improved by suitable treatment, but the patient will have to wear abdominal supports for a long time, if not permanently.

Diagnosis.

1. In all Cases the Kidney must be Clearly Felt to Descend to Too Low a Level in the Loin (the Umbilical Line) before it is Permissible to Account for Certain Symptoms by a Diagnosis of "Movable Kidney."

A "movable kidney" tumour has to be distinguished from other abdominal tumours, especially an enlarged gall bladder, a prolapsed liver, inflammatory or neoplastic swellings of the pylorus, colon, and appendix, a floating spleen, subperitoneal fibroids, and ovarian cysts.

A. *An enlarged gall-bladder* is often present in company with a movable kidney, as tight-lacing and splanchnoptosis predispose to gall-stones by kinking the cystic duct, but it is only likely to be mistaken for a movable kidney in those cases where there is a stone in the cystic duct, with a large mucocele of the gall-bladder, recurrent attacks of biliary colic *unaccompanied by either inflammation or jaundice.* The swelling is rounded and shaped like the lower end of the kidney, and descends during inspiration to a similar degree, but it is felt directly the hand is laid gently upon the front of the belly, and there is no need to sink the hand into the loin to feel it. It appears to ride up firmly against the hand, as if floating on the top of the loin space, and can with difficulty, if at all, be pressed back into the loin and felt behind by the thumb. It can often be felt to be attached to the margin of

the liver, and to present a groove between its anterior surface and the liver margin. It can be moved from side to side, but its vertical movement is dependent on that of the liver. *Light* percussion will always reveal a *dull tympany* or *absolute dulness* over the swelling, which fuses with the liver dulness, whereas a renal tumour has *resonance* in front. There is also resonance in the loin to the *outer* side of the swelling. A movable kidney can often be felt distinct from the gall-bladder swelling lying behind and to the inner side of it. If the colon be distended with air by means of a Higginson's syringe a diagnosis is nearly always possible, as the gall-bladder is pushed upwards and forwards and remains dull, whereas the kidney is pushed back, and exhibits a loud tympanitic note in front of it. Despite the utmost care in observation, the surgeon may still remain in doubt as to the real nature of the swelling and the question have to be settled by exploration.

When the liver is prolapsed and constricted by tight lacing the right lobe is rotated downwards and inwards, and is squeezed out into a kidney-shaped swelling, the margin becoming rounded. It is extremely difficult to distinguish this swelling from a movable kidney, unless the kidney be felt beneath it, and careful light percussion be practised, but the sharper inner edge and the fact that the tumour is dull to light percussion should be distinguishing features.

The diagnosis from the other tumours is made on general lines (see also p. 119).

2. Will the Movable Kidney Account for all the Symptoms or are Other Causes at Work?

It is unwise to operate and promise a cure unless this question has been answered. Are the pain, the dyspepsia, the neurasthenia to be considered as caused solely by the kidney, or are they primary? Is general splanchnoptosis present?

3. Is the Movable Kidney Diseased in other Ways?

Till other diseases have been excluded movable kidney is not a sufficient diagnosis, and routine examination may reveal evidence of infection, tuberculosis, calculus, neoplasm, cyst, etc. An enlarged kidney is often said to become unduly movable from its mere weight, but it only becomes more easily

palpable, and so gives the impression of being unduly mobile and prolapsed.

4. THE PAIN closely resembles the dragging pain and severe crises of renal calculus. It has to be distinguished:

(1) From the other causes of renal colic, especially calculus.

(2) From other pains which simulate renal colic, especially biliary and appendicular colic.

(3) From other causes of dragging pain in the back.

(These questions are discussed in Ch. V, Sect. I).

5. THE "DYSPEPSIA."

It is not uncommon for patients with abdominal pain, attacks of vomiting, and constipation to be treated for gastric ulcer or atonic dyspepsia for a long time, until careful routine abdominal palpation reveals a freely movable right kidney; and nephropexy may completely cure the dyspepsia. In movable kidney the pain is relieved by rest, and bears no definite relation to meals, and the vomiting is only brought on by the pain and does not relieve it. At the same time patients with movable kidney may also suffer from atonic dyspepsia, gastroptosis, dilated stomach and gastric ulcer. The stomach-tube yields valuable evidence of the size and motility of the stomach, of its secretory powers, and a complete abdominal examination should suffice to exclude gastric diseases.

6. THE NEURASTHENIA.

It may be a question of extreme difficulty to decide whether a condition of neurasthenia has been caused solely by the movable kidney, or was present beforehand. Careful cross-questioning of the patient may enable one to determine as to whether the renal crises were the earliest symptoms, and gradually led to the wrecked nervous system.

Treatment.

When there are no symptoms the patient should be informed that the kidney is movable, that it is not a serious condition, and needs no treatment, but she should be warned against heavy lifting and sudden strains.

Treatment concerns itself with—

1. Prevention.
2. Dietl's crises.
3. Palliation.
4. Operation.

1. Prevention.

Young girls should be taught diaphragmatic breathing, and should be encouraged to indulge in regular breathing exercises to strengthen the abdominal muscles. The long hours of standing in bad attitudes in ill-ventilated shops and offices are potent predisposing causes, and proper rest during the menstrual periods would be a great gain.

The corset should be light, and should support but not compress the belly muscles, and should be expansile so that the belly muscles can have proper play and permit diaphragmatic breathing. It *should never be tightened so as to compress the hypochondriac region,* but should extend loosely upwards so as to support the breasts.

Many cases are induced by too early rising from bed after parturition before complete involution of the stretched belly-wall has taken place. The young mother should not be allowed up till her abdominal muscles have recovered their tone, aided, if possible, by abdominal massage, and exercises for the muscles of respiration and of the belly wall. A firm abdominal binder should be used for ten days at least after the child is born, and a belt should be fitted if the muscles fail to involute completely, and the patient must get up.

2. Dietl's Crises.

The patient should lie up in bed, with the foot-end slightly raised, either on her back, or on her right side, and the attack will pass off in a few hours. Hot fomentations, and in severe cases the exhibition of antipyrin, belladonna, or morphia will control the pain.

3. Palliation.

Indications for Palliative Treatment.

1. In all mild cases before operation is considered, unless there is some definite indication for immediate operation (*e. g.* hydronephrosis, hæmaturia, infection, etc., see below).

2. In all cases of general splanchnoptosis, partial and complete, when operation is seldom suitable.

3. In patients with marked neurasthenia, in whom the condition appears to be primary, the kidney merely an episode.

4. In those with chronic cough due to chronic lung trouble, and with morbus cordis.

Palliative treatment consists in the use of mechanical supports to keep the kidney in place, and give time to train up the natural supports, and build up the nervous system by improving the abdominal circulation. In many cases the mechanical support can be dispensed with after a time, if the patient follows out instructions, but in others its use will have to be permanent, as when there is chronic cough that cannot be cured. Mechanical supports need never be worn at night, as recumbency favours the return of the kidney to its proper position, and should always be applied before the patient rises, so that the kidney is in place before the application. If this precaution be not taken it is quite possible for the support to hold the kidney right down in the iliac fossa.

Mechanical Supports proved of Value.

1. *The kidney truss* advocated by Sir F. Treves.

2. A woven elastic belt made to fit the belly accurately and stretching from the pubes to just above the umbilicus. This acts as an artificial transversalis muscle, and can be made by any instrument maker. Newman recommends the incorporation of fine steel supports and the application of an air pad over the front of the loin, which can be inflated to any desired amount after the application of the belt, and thus serves to compress the loin and keep the kidney from descending into it.

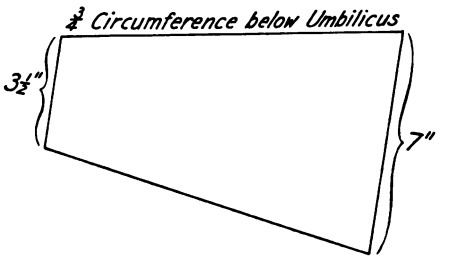
3. Keith advocates the use of Kemp's method. Zinc oxide plaster is spread on a firm rubber backing five yards long, seven inches wide. The skin of the abdomen is cleansed and rendered free from grease. The horizontal circumference of the belly just below the crests of the ilium is measured, and four strips of rubber are cut three quarters the length of this, shaped as in the figure.

The patient lies recumbent; the broad anterior end of the first strip is applied to the left iliac and hypogastric region; the tail is then firmly stretched round towards the right below the right iliac crest; the second is likewise applied,

only on the opposite side; the third is applied to the front of the left loin and round to the right side beneath the ribs; the fourth in a corresponding position but opposite direction.

The support is left on for from two to four weeks, and can then be removed or renewed. It permits of free diaphragmatic breathing, and enables exercises for the abdominal muscles to be carried out at the same time. By restoring the elastic tone of the belly wall, the venous blood is prevented from stagnating in the abdominal veins, so that an adequate blood supply is restored to the systemic circulation and the nervous system. The vicious circle is broken, and the general nutrition of the patient at once improved.

If the patient can afford to lie up a rest cure of some weeks' duration is often the best treatment, as recumbency allows the kidney to return to its normal position, and meanwhile



the muscles of the belly wall are trained to do their duty by exercises, massage, and electricity. General massage, fresh air, regular feeding up, adequate evacuation of the bowels, strychnine, iron, and quinine, and above all the avoidance of worry and overwork all help to build up the exhausted nervous system, and the muscles under its control. Some form of belt will have to be worn for a considerable time after the patient is allowed up, and a regular life and course of exercises must be enjoined if the patient is to remain healthy. Such treatment is especially indicated for those who suffer from primary or secondary neurasthenia.

4. Operative Treatment.

This should be approached with caution. In the type of subject afflicted with movable kidney any striking treatment, especially an operation, is likely to be attended with success

for a time. The surgeon is therefore likely to over-estimate the success of the operation if the cases be not followed up for some years, and in the long run the results will be disappointing unless the cases are selected with discrimination.

The cases that do well are, first, those where some definite organic condition is found, such as a kinked or strictured ureter, or an abnormal blood-vessel—things that are congenital defects and can be remedied; secondly, young women in apparently perfect health save for a grossly misplaced right kidney; thirdly, left-sided movable kidneys occurring alone, which should always be explored.

Cases that do badly are those in which neurasthenic symptoms have been present for a year or more, and in which there is some acquired cause at work likely to lead to recurrence, such as a weak belly wall or a constant cough.

In the majority of cases a prolonged trial should be made of palliative treatment, and operation only be considered if such treatment fails. If after six months' adequate trial there is no improvement it is unwise to continue without an effort to cure by operation, for fear of setting up a condition of neurasthenia, which would persist in spite of rectification of the kidney defect. Operation permits of a complete exploration, which may reveal some definite physical defect in the ureter.

Cases suitable for Operation.

1. Young women with a widely wandering painful kidney, who are otherwise well nourished and in good health.
2. Cases with signs of "intermittent hydronephrosis," especially when minor associated congenital defects are noted (see Ch. VI, Sect. I).
3. Cases with hæmaturia.
4. Cases with renal pain that induces vomiting, and that is always relieved by recumbency.
5. Single, left-sided movable kidneys.
6. When there is evidence of dilatation of the pelvis obtained by the ureteric catheter or of secondary disease, *e.g.* tuberculosis, and other infections, calculus, neoplasm.
7. Women with neurasthenia of less than a year's duration, which in the opinion of the surgeon is caused and aggravated by the movable kidney.

Cases unsuitable for Operation.

1. Patients with total splanchnoptosis or with prolapse of the stomach, liver or pelvic viscera.
2. Confirmed neurasthenics.
3. Cases with chronic cough and heart disease.
4. When the pain is not relieved by recumbency.
5. When there are no symptoms.

Operation.

The operation of anchoring the kidney is called nephrorraphy or nephropexy. The objects of the operation are to explore the kidney *and ureter* thoroughly, as in many cases the whole source of the trouble is revealed in some congenital defect of the ureter, and to "anchor" the kidney by firm adhesions in a suitable position with as little damage as possible to the parenchyma. The operation *deliberately* sets up an *artificial* condition of support. *In health* the kidney is not supported by the delicate fibrillar bundles which run from the true capsule to the perinephric fascia. At operation the true capsule is peeled off the kidney so that tough fibrous adhesions form between the rawed surface of the kidney and the fascia of the posterior abdominal wall. This scar tissue is strong enough to suspend the kidney and anchor it to the back wall of the belly, so that its respiratory movements are limited, but it may stretch in time if the causes of undue mobility persist, at most in two or three years. If sepsis be avoided these new fibrous bands are found not to spread into the kidney or injure the parenchyma in any way by causing interstitial fibrosis. On the contrary, they increase the blood-supply of the kidney and add to its nutrition. Decapsulation, therefore, does no harm to the kidney, and without it the adhesions that form are not tough enough, and fail to accomplish their work.

Palliative measures must receive attention even after operation if causes are still at work that tend to squeeze the kidney out of its natural bed.

The proper position of the kidney for each individual should be determined at the operation by noting the position in which the vessels lie horizontal. If the vessels come off at an abnormally low level from the aorta it is not right to force the kidney right up under the ribs. Each kidney has its own

natural level to be thus determined, and no level can be laid down to which any kidney must be made to conform.

It is important not to cut the last dorsal nerve, which substitutes *hyperæsthesia* of the skin for the renal pain.

The kidney is exposed preferably by the posterior lumbar route, the peritoneal fat stripped off its posterior surface and removed. The ureter and pelvis are explored for abnormalities, and the kidney for signs of hydronephrosis, infection and stone, and the level and nature of the vessels noted. The true capsule is cut along the convex border of the kidney and peeled off the cortex. The capsule can be removed, or can be made use of in applying stitches. Stitches should not be put through the parenchyma. If the capsule is removed the kidney is merely dropped back into its bed; if not removed it is rolled up and anchored by stitches to the muscles of the posterior and lateral belly walls at suitable levels. The twelfth rib, which moves *up* during inspiration, had better not be used as an anchoring buoy. The wound is closed with drainage, and a firm abdominal binder applied.

The after-treatment consists in placing the patient in bed flat on her back, and with the foot of the bed raised on 6-in. blocks. In this way the kidney falls into the most suitable and highest position which it can attain, and becomes anchored there by adhesions. After ten days the blocks are removed, but the patient remains in bed for three weeks at least. Doubtful cases should wear a belt for a time.

Innumerable methods have been published in the last ten years for dealing with movable kidneys, but the method of decapsulation, with stitching of the stripped capsule to the quadratus lumborum (Edebohl's), combined with the head-down recumbent position after the operation, will be found to give as good results as any more elaborate operation.

Results of Operation.

Newman stated that in his cases 75 per cent. were absolute cures, 16 per cent. partial cures, 9 per cent. doubtful, and 1½ per cent. fatal.

Until the cases can be more carefully selected the surgeon is not likely to get any better results than those of Newman. The mortality should be *nil* if a simple method be adopted.

CHAPTER V.

RENAL CALCULUS.

Ætiology.

CALCULI are divided into two ætiological classes:

(1) *Secondary stones* that are formed by the action of bacteria in an inflamed pelvis.

(2) *Primary stones* of which the cause is unknown.[1]

(1) SECONDARY CALCULI.

Bacterial infection arises in one or both kidneys from causes detailed below (Ch. VII). Certain bacteria can split urea into ammonium carbonate and ammonia, turning the urine alkaline and ammoniacal, so that crystals of triple phosphates and calcium carbonate are precipitated, which collect upon the albuminous inflammatory products in the urine, shreds of fibrin, curds of pus or blood-clot lying on the surface of the pelvic mucous membrane. A nucleus once formed, a large stone is rapidly built up around it composed of triple phosphates and calcium carbonate, bound loosely together by an albuminous matrix, and which moulds itself to the cavity of the pelvis and calices.

Secondary calculi occasionally arise with a nucleus formed of blood-clot, the relic of a past hæmaturia; or of the body of a parasite such as the *Bilharzia hæmatobia*; or round other foreign bodies, such as a bullet. It is possible that most so-called primary calculi are the result of mild bacterial infections of the kidney, which are hardly noticeable and which rapidly clear up, leaving behind small masses of casts, fibrin, or blood-clot, which become nuclei for the deposit of crystals, an hypothesis based on the analogy of the formation of gall-stones.

(2) PRIMARY CALCULI.

The complete chain of causation is not known.

Two conditions are necessary for the formation of a calculus:

[1] See, however, Appendix A.

(1) The deposit of crystals from the urine while still within the kidney.

(2) The deposit in the urine of an albuminous substance to act as a nucleus and matrix for the stone.

(1) *The Deposit of Crystals.*

Many individuals, at varying periods of their existence, pass urine that is turbid with deposit of crystals, such a condition being spoken of as "gravel." Very little is known as to the true causation, and the condition is not always easy to influence by treatment, nor do such persons necessarily develop calculi. The "gravel" may consist of three different classes of bodies:

(A) Uric acid.
(B) Oxalates.
(C) Phosphates.

(A) *Uric Acid.*

The uric acid is derived from two sources: "Exogenous," from the nucleins of the food; "endogenous," from the products of metabolism of body-cells rich in nucleins. The in-take of the nucleins can be controlled, but little can be done to control the endogenous production of uric acid, which bears an obscure relation to gout, in which an inherited defect of metabolism seems to play an important part.

The average amount of uric acid passed in the twenty-four hours varies from 5–15 grains. A deposit of uric acid in the urine does not necessarily mean an excess, as uric acid tends to be deposited in highly acid urine, or when the quantity of sodium chloride and urinary pigments is deficient. Persons may therefore deposit uric acid gravel, not because they are passing excess of uric acid, but because the urine is too acid, or contains too little sodium chloride or pigment. Other factors no doubt are at work which are quite unknown.

The following conditions are often said to lead to the deposit of uric acid gravel—a sedentary life, excess of animal food and of alcohol, the gouty or glycosuric diathesis. Uric acid gravel can exist by itself quite apart from gout, and can last for years without noticeable effect on the health of the patient and without leading to stone formation.

In the kidneys of children at birth it is very common to find definite sand in the tubules and calices formed of

ammonium and sodium urate. This is washed away in the urine stream during the first few weeks of life, but if this flushing remains incomplete the sand remains and forms nuclei for stones composed of urates, which are not uncommon in children before the age of ten years, especially in children of the poorer classes.

(B) *Oxaluria.*

Calcium oxalate is present in the urine in health, the daily quantity being 20–35 milligrammes, and it is said to be derived partly from the calcium and oxalic acid in the food, and partly from that produced endogenously by the metabolism of the tissues. It has also been said to be derived from the nucleins, and to bear a close relation to uric acid, with which it is often associated in the urine. It it held in solution by the acid sodium phosphate and the magnesium salts of the urine. A visible deposit does not necessarily mean an excess of the salt, and is deposited in acid urine which may contain a trace of albumen. The patients are often of the neurasthenic type, and suffer from hyper-acid dyspepsia; but they do not by any means necessarily develop stones.

(C) *Phosphaturia.*

Quite apart from the local cause of deposit of triple phosphates—namely, bacterial infection and decomposition of the urine—general conditions arise in which crystals of calcium and magnesium phosphates are deposited in faintly acid, neutral, or alkaline urine as a white deposit which disappears on the addition of acetic acid. This is not due to an excess of phosphates in the urine, but is due either to a deficiency in the acidity of the urine from the intake of excessive alkali in a too vegetable diet, or from hyper-chlorhydria; more often it is due to a general disorder of nutrition closely bound up with the nervous system which is is in a state of anxiety, depression, or overwork, frequently combined with some local cause of irritation, such as urethritis, prostatitis, or sexual excess. It occurs chiefly in young, overworked, unmarried males. The condition is due to an increase in the amount of fixed alkali in the urine rather than to an increase in the amount of phosphates, and yields to plenty of animal food, active exercise, fresh air, and tonics such as iron, quinine, and the mineral acids. Such patients do not often develop stones.

The symptoms are aching pains in the back, increased frequency of micturition, and a scalding pain on micturition.

(2) *The Deposit of an Albuminous Substance.*

A colloid organic material is required to bind together the crystals of a stone, and is found to be an albuminous substance deposited from the urine, but no satisfactory explanation of the actual cause of the deposit of this substance has been put forward.[1]

1. It may be caused by a mild attack of catarrhal inflammation of the kidney and pelvis, toxic or microbic in origin, which passes away unnoticed.

2. It may be the product of an inflammation excited by the mere passage of urine containing deposited crystals. Ebstein produced stones in animals by feeding them on oxamide, which produced a desquamative catarrh of the tubules, the products forming the nuclei and matrices of the stones.

3. It may be a secretory neurosis, analogous to that of "mucous colitis," and bound up with a general functional disturbance of the nervous system, which also appears to control the deposit of crystals in the urine. (In mucous colitis colonic sand or gravel may be deposited.)

4. According to Moritz this albuminous substance is to be found in the sediment of normal urine, and if a crystal in the urinary sediment be dissolved under the microscope it leaves behind a fine albuminous shadow of the crystal. On this hypothesis the passage of gravel is the primary condition, the albuminous catarrh a necessary concomitant, the determining cause being anything that slows the stream or makes a back water.

Two main hypotheses appear to hold the field:

1. Renal calculus is a local disease, and depends for its formation on local causes.

2. Renal calculus is part of a general disease, which finds expression in the deposit in the urine of crystals and of albuminous material.

Predisposing or Incidental Causes.

Patients apply for relief mostly between the ages of twenty and fifty. In children and in old men urinary calculi are common, but are more often met with in the bladder than in

[1] See Appendix A. An abstract of a recent paper by Schade which throws fresh light on this question.

the kidney. In children they are the heritage of the uratic sand present at birth; in old men they are the result of a gouty diathesis and an enlarged prostate.

Males are said to be more frequently affected than females, but according to Küster, in 713 cases there were 368 males and 345 females, so that the difference is not very marked.

The tendency to gout and to the deposit of uric acid in the urine tends to run in families, even when the different members of the family scatter far and wide and live under different conditions of food and soil. The family history may therefore be an aid in diagnosis. "Cystinuria" is undoubtedly a family disease.

In Europe Jews are said to be affected more often than Christians, and in India Mohammedans more often than Hindus.

Stone is more common in warm climates, possibly because less water is passed through the kidneys and more through the skin.

An excessive vegetable diet, rich in calcium salts, oxalates, and phosphates, is undoubtedly a predisposing cause in certain cases of primary oxalate and phosphatic stones. An excess of purin bodies in a rich animal diet is often blamed for the origin of uric acid gravel. Excess of animal or vegetable diet therefore seems equally dangerous—an argument in favour of a mixed dietary.

Water containing excess of calcium salts has been blamed as an important predisposing cause of calculi, and dwellers on chalk or limestone soils often suffer from stones.

A sedentary life, excess of rich animal food, excess of alcohol, are likewise blamed, with how much justice is doubtful, since the poor manual labourer does not escape his share of calculi. *Deficient daily in-take of plain water* is a common fault that must be an aggravating cause.

Injury is often adduced by the patient to account for the onset of the trouble, and undoubtedly a severe blow on the kidney may, by causing bleeding, give rise to the nucleus of a stone, but more often the blow has but stirred up a quiescent stone already formed.

The right side is the more often affected, according to Küster, who found in 764 cases 90 on both sides, 383 on the right, 288 on the left, but other authorities declare that both sides are equally affected, though the predominance of movable kidney on the right side might account for the difference.

Stones occur in both kidneys in 50 per cent. of the cases, according to Legueu, but this probably gives an exaggerated idea for practice, being based on post-mortem records, as Morris found stones in both kidneys in only 10 per cent. of the cases on which he operated. Still, the fact that stones are quite commonly present on both sides should make the surgeon very cautious in prognosis and treatment until a *complete X-ray examination of both kidneys and ureters* has been made. *Uric acid stones are most commonly bilateral, just the ones which are sometimes missed by the X rays.*

Pathology.

Composition and Structure of Renal Calculi.

A. *Primary.*

1. Common	Uric acid	Formed in *acid* urine.
	Ammonium and sodium urate	Often mixed together in the same stone.
	Calcium oxalate	
	Calcium phosphate	Often mixed, formed in neutral or *alkaline* urine due to *fixed* alkali.
	Calcium carbonate	
2. Rare	Cystin (" green stone ").	
	Xanthin (reddish-brown, mixed with uric acid).	
	Blood stone.	
	Indigo (" blue stone," two examples on record).	

B. *Secondary.*

Ammonium and magnesium phosphate	Deposited in alkaline urine due to decomposition of urea by micro-organisms. Often formed around " primary " stones.
Calcium phosphate and carbonate	

Primary stones are named after their chief constituent. They seldom consist purely of uric acid, of oxalate or of calcium phosphate, but contain one of these bodies in predominant quantity, interspersed with a lesser quantity of the others.

Any number of stones may be present, and the size may vary roughly from that of a pin's head to that of a clenched fist. Stones are rarely found in the tubules of the kidney, but *lie either in the pelvis, or in a dilated calyx* the narrow neck of which prevents their falling into the pelvis. Smooth

stones remain movable, and either pass easily, or act as ball-valves at the entrance to the ureter causing intermittent blockage; spiculated stones sink into the irritated and œdematous mucous membrane and become fixed and allow the urine to flow past them. The large phosphatic calculi are often intimately adherent to the mucous membrane, and require to be stripped out of their bed.

Bacteriological investigation of primary stones shows that the centre may be sterile, but frequently it contains such organisms as the colon bacillus, streptococci and staphylococci.

Structure of a Stone.

A stone consists of a nucleus formed by one of the primary elements, round which can be seen concentric laminæ of fresh constituents, either alternating layers of uric acid and oxalate, or concentric layers of the same substance marked out from one another by the varying quantity of pigment in each layer, or by the opposition of crystal arranged in a radiating manner. The laminæ may consist of layers of crystals, or of amorphous granular matter. If the urine has become alkaline from infection, the outer layer of the stone consists of a mortar of triple phosphates and calcium carbonate, the laminated portion of the stone appearing as though set in a plaster mould. Rainey and Ord found that the presence of colloid in solution profoundly alters the characteristic shape of crystals; thus calcium oxalate should be deposited as regular octahedra, but in the colloid urine these are rounded off into rhombic prisms and "dumb-bells," a fact which explains why large stones do not assume the shape of the normal crystals. Microscopically the stone consists of atypical crystals packed together in bundles, and cemented by amorphous deposit of urate, pigment, and albuminous material.

Varieties of Stones.

Uratic calculi in adults consist mainly of uric acid, sometimes accompanied by urates; they are hard, rounded, and smooth surfaced, sometimes polished, sometimes facetted; they vary in colour from a pale yellow to a dark reddish-brown, and on section present concentric laminæ of varying colours dependent on the variations in the urinary pigment as the layers were deposited, the structure being amorphous; they vary in size from that of a small shot to that of an orange, and may be single, but are usually multiple.

In children the stones consist of ammonium and sodium urate, are small, friable, and coloured a pale fawn or buff. Occasionally a pure uric acid calculus is rough and friable, and a brilliant reddish-brown. Pure uric acid calculi do not cast a shadow under the X rays, but *as uric acid stones usually contain a certain amount of oxalate crystals they seldom fail to give a dim shadow on the X-ray plate.*

Calcium oxalate stones.—These appear in several different forms, and often contain a fair proportion of uric acid or calcium phosphate, which is worked in as an amorphous deposit between the crystals of calcium oxalate.

1. *The "mulberry" calculus or "hedgehog"* is hard, irregularly spiculated, and of irregular shape; is usually single, seldom larger than a filbert, and takes years to grow (five to fifteen). On section it is crystalline, and on the outer margin presents laminæ irregularly disposed, corresponding to the irregular outward form, but towards the centre the laminæ are often more rounded and regular. It is the hardest and roughest of all stones. The colour varies from a light to a very dark brown or even black, depending upon the amount of altered blood and other pigment incorporated with the stone. Rarely the stone presents a shining, glistening, white crystalline surface.

2. *The smooth "seed" calculi.*—These are quite common, and are usually multiple, small, and easily passed, their surfaces being smooth and rounded, the colour usually a pale grey, rarely black. They contain a certain amount of uric acid and calcium phosphate mixed up in them, and seldom attain a larger size than that of a cherry-stone.

3. *The spiked form.*—This is exceedingly rare and consists of a central hub to which are attached long, radiating spikes at regular intervals.

Calcium oxalate calculi give the densest shadows of all stones under the X rays, unless mixed with large amounts of uric acid.

Primary phosphatic stones are not so very uncommon. They are whitish-grey, or yellowish-white, the surface slightly irregular and covered with delicate crystals. On section they show a fine lamination, are crystalline throughout, and are pale white and friable; they are usually small single stones, not larger than a filbert, grow slowly, and are deposited in urine faintly acid or neutral. Phosphatic calculi in aseptic urine throw a good shadow under the X rays, less dense however than that of calcium oxalate.

Calculi of mixed phosphates (*secondary*).—These are either a dirty white, mortar-like, and friable, or may be dirty yellow-brown, and covered all over with shining crystals of triple phosphates. They have no laminated arrangement on section, but are welded together into a granular mass. They are often multiple and may attain a very large size. They grow very rapidly, and mould themselves to the shapes of the dilated pelvis and calices in which they lie, and become fixed, and for this reason may therefore present a shape like a cast of the pelvis with a nose projecting into the ureter, and knobbed branches corresponding to the calices.

When infection takes place in a kidney that contains a primary stone, a layer of mortary phosphates is deposited round the surface of the primary stone, and soon modifies its appearance.

Cystin stones are smooth and yellow when removed, but on exposure the colour changes to a soapy-green. On section they are translucent, soapy-green, and show a striation radiating from the centre as opposed to most other urinary calculi, which are concentrically laminated or amorphous. They are very uncommon, are single or multiple, and may attain a large size; they are soft and waxy, often contain other constituents, such as uric acid and oxalates, and cast a good shadow under the X rays.

The following details are taken from the "Croonian Lectures," by A. E. Garrod, 'Lancet,' July 11th, 1908, and July 18th, 1908: Cystin is one of the primary fractions into which protein splits up within the body, and contains most of the sulphur of the protein molecule. In normal persons this substance is finally turned to sulphate and excreted as such in the urine, but in certain individuals, owing to an hereditary defect of metabolism, this change does not take place completely, and part of the cystin is excreted as such in the urine, and such persons may develop calculi consisting of cystin. The disease runs in families. Urine containing cystin may acquire a greenish tinge, and when decomposed gives off a characteristic odour of sulphuretted hydrogen. If acetic acid be added to a drop placed under the microscope crystals consisting of hexagonal plates are seen, which are readily soluble in ammonia.

Xanthin is closely related to uric acid, is sometimes found in uric acid stones if looked for, and is a reddish-brown substance. The stones are smooth and rounded, show a lamellar structure, and are deposited in acid urines.

Blood stones consisting of blood-clot are very rare, but it is not uncommon to find adherent blood-clot attached to ordinary stones when they are freshly removed from the body.

Indigo.—Two instances of indigo stones are on record, the indigo being derived from indican, the product of bacterial decomposition of proteid in the small intestine.

Secondary Pathological Changes Produced by a Primary Calculus.

A. On the Affected Kidney.

(1) *Aseptic changes.*
- (a) *Free outlet; Chronic irritation.*
  - (1) Local fibrosis.
  - (2) General fibrosis, with hypertrophy—large fibroid kidney. With atrophy—shrunken fibroid kidney.
  - (3) Papilloma and carcinoma of renal pelvis (very rare).
- (b) *Obstructed outlet to mouth of ureter or calyx.*
  - (1) *Complete,* causing atrophy of kidney.
  - (2) *Incomplete* (misfit, ball-valve, or channelling), causing hydronephrosis—partial in calyx, complete in pelvis.

(2) *Septic changes.*
- (a) *Pyelo-nephritis,* simple or suppurative.
- (b) *Pyonephrosis,* partial or complete.
- (c) *Perinephritis and perinephric abscess, "lipomatosis"* of kidney and of fatty capsule.
- (d) *Fistula* to skin, bowel and neighbouring organs.
- (e) *Formation of secondary phosphatic calculi.*

B. On Opposite Kidney.

(1) *Compensatory hypertrophy.*
(2) *Formation of stones,* especially in uratic cases.
(3) *Toxic nephritis.*
(4) *Microbic nephritis,* descending or ascending.

Pathological Changes that Accompany Secondary Calculi.

(1) *Suppurative pyelonephritis.*
(2) *Pyonephrosis.*

A stone by its mere presence in a calyx gives rise to chronic inflammation of the kidney substance in its neighbourhood. There is increase in the connective-tissue network around the tubules, with catarrh and atrophy of the kidney tubules, and the process may take place throughout the whole of the kidney, if it is being irritated by the constant passage of the stone-forming elements, as in the gouty kidney. A malignant papilloma or an excavating epithelioma sometimes arise in the pelvis from the irritation of a stone.

If a stone blocks the mouth of the ureter completely the whole kidney ceases to secrete, and undergoes atrophy and fibrosis, and after six months to a year it is very unlikely that it will recover its function if the obstruction be removed. If the block is incomplete, secretion continues and a hydronephrosis is produced. If there be incomplete obstruction to one calyx secretion continues, and dilatation of the calyx occurs with thinning out of the cortex of the lobules which supplies that calyx, so that the stone comes to lie at the bottom of a thin-walled cyst, which presents on the surface of the kidney, and can easily be recognised by the finger at operation. *Stone is the commonest cause of single cyst in the kidney met with at operation.*

Sooner or later bacteria make their way to the affected kidney, usually by way of the blood (see Ch. VII), causing rapid destruction of its substance by suppurative pyelonephritis, and it is quickly changed into a partial or complete pyonephrosis. Pus may make its way into the surrounding tissues leading to a perinephric abscess, and if it bursts either on to the skin or into a neighbouring organ the stone may be discharged from the kidney. Usually there is intermittent discharge of pus by way of the ureter, which serves to keep the pyonephrosis imcompletely drained, and prevents its giving rise to local spread to the surrounding tissues or to severe general toxæmia. If the infecting bacteria are able to split urea the urine becomes ammoniacal, and secondary deposits of triple phosphates and calcium carbonate are quickly plastered around the calculus, and fresh secondary calculi of like nature form, moulding themselves to the pelvis and calices.

If the infective agent be a very mild one suppuration does not occur, but the kidney and its surrounding capsule change into a dense mass of fibro-lipomatous material, almost of the consistency of cartilage, and consisting of dense bands of

fibrous tissue surrounding islands of fat cells, while the parenchyma cells disappear—a condition that should not be mistaken for a neoplasm or diffuse lipoma of the fatty capsule, and that can occur in other mild infections of the kidney, such as chronic tuberculosis.

If one kidney is badly damaged by stone the other kidney undergoes compensatory hypertrophy, but in many cases, especially the uratic, the other kidney may be fibrotic and may also produce stones, as it is being irritated by the same toxic condition of blood as the affected kidney. Statistics vary greatly as to the frequency with which stones are found in both kidneys, but it is a possibility always to be borne in mind, especially in uric acid cases.

When infection of the stone kidney has occurred increased danger to the other kidney arises, and it may become infected also either by the ascending or descending path.

Clinical Symptoms and Signs.

The classical symptoms of renal calculus are *fixed renal pain, renal colic,* and *hæmaturia.* Since in many cases the symptoms are atypical or even absent altogether too much trust should not be placed in them, and modern diagnosis depends on *physical signs* rather than *symptoms,* elicited by a complete routine examination of the urogenital tract, especially the signs yielded by the Röntgen rays. Before their advent stones were approached in the dark; now with their help the presence and position of a stone can be fixed with precision, and the stone approached on scientific lines.

The long periods of latency are the most striking characteristic of cases of renal calculus. Intervals of years may intervene between short periods of colic and hæmaturia. *A history of three to four years of renal pain or colic, increased by movement and punctuated by slight attacks of hæmaturia, the urine otherwise remaining clear save for the passage of crystals, is strongly suggestive of this affection, and the need for an X-ray examination can be confidently urged.*

Local Symptoms.

PAIN is of two varieties:

1. ***Fixed renal pain.***
2. ***Spreading renal pain.***

1. ***Fixed renal pain*** is felt most intensely in the back of one loin beneath the subcostal angle, and may spread to the side

and front of the loin and epigastric region. It is a persistent continuous pain sticking to the same place, and which varies in intensity from a dull, heavy ache to a sharp cutting pain, which is seldom sufficient to force the patient to stay in bed. It may come on every day, or may be absent for weeks together, and is often brought on by jolting movements, such as walking downstairs, riding in an omnibus, and by anything which tends to produce renal congestion, such as menstruation. It is relieved by rest, and is therefore absent during the night.

This pain appears to be produced by stretching of the capsule either from irritative congestion of the kidney or from bleeding, or from intermittent blocking of the mouth of a calyx or the ureter. During the aseptic period renal congestion is seldom intense, and the patient is found to lie in bed on the affected side so as to keep the kidney firmly cushioned. When infection occurs the congestion is aggravated, and the pain is now felt as an intense burning, worse by night even than by day, and the patient is found to prefer the opposite side to lie upon as the kidney is too tender to bear any pressure.

Sometimes the pain has the character of a *sharp stab* felt during any sudden movement of the trunk in the region of the kidney, and passes off in a few moments.

(2) *Renal colic* is caused by cramp set up by too forcible contraction of the muscle coat of the pelvis and ureter, and is produced by a stone that partly blocks the mouth of a calyx or the ureter, or by a stone that is moving down the ureter towards the bladder, or by the passage of blood-clot.

The attack comes on quite suddenly, induced by some sudden jerking movement of the trunk, such as stooping down quickly to put on the boots, or jumping off a raised object. The patient turns deathly pale, flings himself down doubled up with pain, and consumed with nausea, vomits, and breaks out into a cold sweat. In a few minutes the pain abates somewhat and gives way to continuous renal ache, only to return again after a short interval with increasing severity. In this way the agony comes and goes, it may be for many hours, until the stone is passed or the muscle-wall of the ureter is exhausted by excessive effort or by drugs.

The pain radiates from the back to the front of the loin, down the linea semilunaris in the course of the ureter to the testicle or ovary and labium majus; thence it may spread in many directions down the front and back of the thigh, into the

bladder-neck and perinæum, and to the end of the penis; rarely it spreads to the opposite side of the body. The skin and the testicle of the affected side become exquisitely tender and intolerant of the slightest touch. The patient feels an intense desire to micturate every few minutes, but passes nothing save a few drops of blood-stained urine (strangury). During a severe colic the unaffected kidney secretes very little urine.

A few cases have, without much doubt, occurred in which the pain was always felt on the side opposite to that on which the stone lay, but cases that can survive a thorough criticism are not common. Even with the X rays it is possible to miss the presence of small uratic calculi on the side of the pain, and to find a large calculus on the other side, and small stones are far more likely to yield striking symptoms than large ones. The pain is explained as a reno-renal reflex and compared to reflex anuria. It is a pity to lay much stress on these cases, as they are a temptation to slovenly diagnosis, and many of the cases rest on insufficient evidence, and have not been submitted to complete and repeated examinations.

Hæmaturia comes on *shortly after* the start of the pain, which is the onset symptom. It is seldom profuse, rarely lasts more than twenty-four to forty-eight hours, and tends to recur at long intervals over a period of years, during which there may have been several attacks of pain unaccompanied by noticeable hæmorrhage. It is produced by jolts and jarring movements. The patient often fails to notice the blood as such, the urine being merely smoky.

In these ways the hæmaturia differs from that of neoplasm, which is profuse, precedes the pain, is independent of movement and often starts during sleep, and recurs over months rather than years.

Increased Frequency of Micturition.—This may be a very marked symptom in cases where the pain is quite mild and the urine clear, being an expression of renal irritation. It is present during the day-time, while the patient is up and at work, but does not cause trouble at night, and may be accompanied by attacks of "gravel."

Strangury only arises during attacks of colic, and is not infrequently absent even then, but when present it is a most reliable diagnostic sign, consisting in an intense desire to pass water every few minutes, the attempts to do so being ineffectual, or producing only a few drops of blood-stained urine, which burn the urethra.

Cloudy Urine, Gravel and Pyuria.—The passage of "gravel" is a common complaint that causes the patient to seek advice, and at once arouses a strong suspicion of stone, and indicates an effort to exclude it. In the septic stage the patient complains that the urine is hazy or thick, and burns the urethra.

General Symptoms and Signs.

Gastro-intestinal disturbances, attacks of nausea, vomiting and griping diarrhœa are common complaints, and may dominate the picture to the exclusion of all other symptoms, being caused by the pain acting on the nervous system, especially in severe colics, or being less commonly of uræmic origin.

Mild attacks of colic, and the latent periods in between, show little evidence of effect on the general health or the temperature chart, but during a severe colic the temperature rapidly falls to 96–97° F., and the patient suffers from collapse and shock, but unless the kidney is infected there is an absence of pyrexia during the period of recovery from the primary collapse which helps to distinguish the disease from perforative peritonitis.

In the septic stage rigors and pyrexial attacks occur characteristic of pyelonephritis, and the patient wastes rapidly (see Ch. VII, Sect. I). Some of the infected cases run a chronic course of months or even years, if the infecting organism be mild, and the ureter be not blocked so that the kidney can drain itself. Attacks of intermittent fever appear at intervals, caused either by an access of virulence on the part of the organism, or by blocking of a pus cavity. When the block is relieved the urine contains more pus, but the symptoms cool down. Other cases acquire more virulent organisms which can split urea; the septic absorption is marked, the kidney substance is rapidly destroyed, and the patient quickly goes down-hill towards a fatal issue if nothing is done to relieve him.

Local Signs.

Abdominal Examination.—This may reveal nothing, especially during the latent periods, but when the kidney is aching *areas of skin tenderness* may be elicited on the same side over the areas of skin supplied by the tenth, eleventh, and twelfth dorsal nerves. These areas appear almost simultaneously

with the onset of pain, and tend to spread to neighbouring areas as the pain grows more severe, and fade away *some hours after* the ache has gone. In men, and on the right side in both sexes, these areas are valuable evidence that one of the abdominal viscera is disordered, but they tell little more than that, unless taken in conjunction with the other signs.

Points of deep tenderness at certain spots are very characteristic, and may be elicited during periods of complete latency. Examination is made with the point of the forefinger pressed in deeply, firmly, and rather suddenly. At some one spot a point will be found where the patient winces, and may cry out that he is being stabbed with a knife, but the pain is not always so sharp as that. The points are found behind in the costo-vertebral angle, beneath the tip of the tenth rib, and at the top of the ureter in front; they may also be found at points corresponding to the course of the ureter in the front of the abdomen along the edge of the rectus muscle.

During a colic the belly is rigid and sunken, the skin being so tender that deep palpation is impossible.

The kidney may not be enlarged, but it is usually tender if it can be grasped, though the muscles often prevent this by contracting just at the last moment as the fingers sink into the loin. If an enlarged kidney can be felt it may be a pyonephrosis, or an hypertrophied kidney, the other side being more extensively diseased; rarely it is a hydronephrosis, but in 386 cases of hydronephrosis Henry Morris found only five caused by a stone. Sometimes a bag of very large stones can be felt as hard masses that suggest carcinoma; and grating between the stones may rarely be elicited. The large tender kidney may be the healthy kidney, or both kidneys may be enlarged, though only one contains a stone. During a colic, and for some hours after, the testicle on the affected side is drawn up and exquisitely tender, the skin over it being dusky with vaso-motor flush.

Rectal and vaginal Examination may reveal the presence of an impacted or moving stone low down in the ureter.

The Urine is strongly acid in uric acid and oxalate cases, amphoteric or faintly alkaline in primary phosphatic cases, ammoniacal in secondary phosphatic cases. Fœtor denotes severe secondary infection with urea-splitting bacteria. An odour of sulphuretted hydrogen denotes cystinuria. The specific gravity is high (1030–1035) in favourable uric acid cases, persistently low (1008–1012) in unfavourable gouty kidney cases, and is low in primary phosphatic cases (1004–

1015). The daily amount of urine varies inversely with the specific gravity so long as health is maintained. Albumen, apart from hæmaturia, is often *completely absent*, but a faint trace may be detected in aseptic cases, and in septic cases the amount is in proportion to the blood and pus. Sugar is frequently found in stout, elderly subjects.

URINARY DEPOSITS.—(1) *Crystals or "gravel."*—Oxalates are seen as a brilliant white deposit, which sticks to the sides of the test-glass, and does not settle down for hours; uric acid is seen as a light pink or reddish-brown deposit, which disappears on heating or on the addition of liquor potassæ; phosphate as a milky pus-like cloud, which disappears on the addition of acetic acid.

(2) *Blood*, when present, renders the urine smoky rather than a bright red. Red worm-like casts of the ureter at the bottom of a clear urine denote a renal origin for the blood.

(3) *Pus* is present in the septic stages in varying amounts.

Microscopic examination often reveals the presence of a few red and white blood-corpuscles, when the urine appears clear to the naked eye, especially if the evening urine be examined. Characteristic crystals may be detected, such as the octahedra, rhombic prisms, and dumb-bells of the oxalates, the stellate or coffin-lid phosphates, the whet-stones, barrels and amorphous urates, and very rarely the hexagonal cystin plates.

THE CYSTOSCOPE is used to exclude a vesical origin for the symptoms, to detect changes in the mouth of the ureter, and to explore the ureter and pelvis with catheter and bougies.

URETERIC MEATOSCOPY.—The size and shape of the ureteric orifice, the frequency and strength of the jets of urine are noted on each side, and the character of the urine if tinged with blood or pus. When a stone is descending the ureter the mucous membrane around the mouth is red, swollen and œdematous, and sometimes shows petechiæ, the mouth itself being altogether hidden, or the mouth may be so swollen as to project like a polypus. A round open mouth like a golf hole, which discharges tapes of viscid pus at long intervals, denotes an obsolete adherent pyonephrosis that needs removal. Rarely a stone is seen projecting from the ureteric orifice.

URETERIC INSTRUMENTATION.—Catheters, the surface of which are marked out in inches, are passed to the pelvis of each kidney, while the operator calls out the inches as he sees the marks disappear, so that if one catheter is stopped at any

point the exact distance of the obstruction up the ureter is known at once. Specimens of urine are withdrawn from each kidney and completely analysed (see Ch. I). Some surgeons perform this manipulation without an anæsthetic, which is apt to upset the kidney values. Small quantities of non-irritating aseptic fluid are then injected into each catheter so as to distend the pelvis and ureter and cause pain, the patient being then asked to declare whether the pain is the same as his usual pain or different. (Kelly's method of "artificial colic"). This method is seldom necessary, as there are many better methods of making a satisfactory diagnosis. A catheter may slip past a stone, and Kelly advocates the use of a catheter tipped with wax to take scratch marks—a method which is uncertain, is liable to the fallacy that the wax may be scratched by the edge of the cystoscope, and can only be required in those cases in which the Röntgen rays have failed (2–4 per cent.), which are those of the small, smooth uric acid stones, stones little likely to scratch the bougie, and there is also a risk of leaving a little wax behind.

The method of passing solid bougies in which iron oxide has been incorporated after which a radiograph is taken was introduced by Hurry Fenwick ('Brit. Med. Journ.,' June 17th, 1904), and by this method he has been able to exclude many sources of fallacy in X-ray examinations (*vide infra*).

Kelly's tubes may be used in females to carry out these manipulations, and enable metal sounds to be passed up the ureter.

Examination with Röntgen Rays.

Radiography has revolutionised the surgery of nephrolithiasis, as in the hands of experts it enables an accurate diagnosis to be made in at least 96 per cent. of the cases. The clinical signs and symptoms being seldom unequivocal are now chiefly of value, in that they lead to a *complete* X-ray examination of the *whole urinary tract, kidneys, ureters, and bladder. Partial* examinations are *useless,* as a stone low down in one ureter may give all the signs of a stone in the kidney. *In all cases of obscure one-sided pain in the back, abdomen, or lower limbs, a complete X-ray examination for stone is advisable*—to exclude stone being often of sufficient value to make the examination worth while.

The screen method advocated by Shenton and others is not reliable, nor is a "positive" of much value.

The examination of the negative itself is imperative for accurate work.

The patient lies flat on his back, the thighs being flexed on the trunk if the lumbar curve is excessive. Two 12 in. by 10 in. plates are placed under the lumbar and sacral regions, so that the stone shall lie as near to the plate as possible. The respiratory movements of the belly wall are restrained by pressing a broad abdominal bandage firmly across the belly and tying the ends to each side of the couch, the patient being instructed to breathe quietly with the thorax only. The tube is always placed in the same relative position to the body, vertically above the umbilicus, save in exceptional circumstances (see p. 90). A soft tube and a long exposure of two or three minutes' duration are used so as to bring out the outline of the psoas muscle and kidney, for if these are clearly defined it is unlikely that a stone which is more opaque will not also be outlined. In fat persons it is sometimes well to repeat the examination if it is negative, and in the cases of suspected mimetic shadows the passage of iron oxide bougies with a subsequent exposure to the rays will usually enable a correct opinion to be formed. The full clinical interpretation of the negative *should always be made by the clinician,* as the complete bearings of a shadow throw much light not only on diagnosis of the condition of the kidney, but on prognosis and treatment.[1]

The following rules and inferences are taken from Mr. Fenwick's book:

The bowels must be thoroughly cleared out with a *vegetable* purge before radiography, to exclude opaque bodies in the intestines.

Note the *density, shape, size,* and *position* of a shadow.

The *number* of stones present cannot be *certainly* stated. A single shadow may be cast by a collection of a number of small stones.

The density.—Oxalate of lime throws the densest shadow; next in order comes cystin; then primary aseptic phosphate of lime. Secondary stones of triple phosphate throw a fair shadow outside the body, but when within an inflamed and purulent kidney they may hardly show up at all, and may be missed, though of great size. Pure uric acid stones do not cast a

[1] A fuller account of this subject will be found in the following book and papers: E. Hurry Fenwick, 'The Value of Radiography in the Diagnosis and Treatment of Urinary Stone,' J. & A. Churchill, 1908; 'Brit. Med. Journ.,' June 17th, 1905; 1902, vol. xi, p. 117.

shadow at all, but they are not common, oxalate and phosphates being usually combined with them in small amounts.

A sharply defined shadow in the renal area of a young adult who suffers from symptoms of stone (the urine being oxalescent and aseptic) indicates an oxalate-of-lime calculus.

The shape.—A stone shaped like a nose pointing to the second lumbar vertebra often denotes a blocked ureter.

The position of the stone can only be used for inferences when the following conditions have been fulfilled:

The tube placed vertically over the umbilicus;

The mobility and size of the kidney known;

The right and left sides of the body marked on the plate.

Landmarks used in locating a shadow.—The mid ileo-costal vertical line is a line drawn from the centre of the iliac crest vertically upwards to cut the last rib. It is named the "mid-vertical" line. Shadows outside this line are usually cast by the contents of the bowel. Shadows inside this line are usually urinary shadows, rarely cretaceous lumbar gland shadows, rarely the bowel. Shadows arranged along the mid-vertical line are not infrequently stones in the cortical portion of the kidney. The surgeon should hesitate to diagnose a shadow outside this line as urinary without further investigation. At the same time shadows cast by objects in the bowel may occur inside this line. Stones in the pelvis of the kidney usually fall well within this line. In a patient with a huge pyonephrosis which is also displaced downwards, shadows may be cast by stones in the pelvis which fall below the crest of the ilium, and well outside the mid-vertical line. Discrete shadows arranged along the mid-vertical line usually denotes stones in dilated calices, or in other words cortical stones which are situated in the cortical area of the kidney as distinct from those in the pelvis of the organ. Widely isolated cortex stone-shadows do not necessarily denote widely isolated stones. The separation of cortical shadows is an indication of fluid between stones, that is to say, they denote a uronephrosis, partial (cyst) or complete; in other words, past or present back-pressure in one calyx, or the whole pelvis. A shadow inside the mid-vertical and in the lower half of the loin-space, the kidney being not displaced, is probably cast by a ureteric stone.

Shadows in the upper ureter.—The ureter shadow marked out by a bougie forms a vertical line which touches the tips of the lumbar transverse processes from the second downwards.

Fallacy 1.—The shadow of a ureteric stone may be faint and may fuse with that of a transverse process. If this is suspected a fresh radiogram should be taken, the tube being placed to one side of the umbilicus.

Fallacy 2.—If the kidney be much displaced, a pelvic stone may cast such a shadow. The iron oxide ureteric bougie evades this difficulty, and the routine examination at operation of the ureter before the kidney in case of doubt.

Influence on Treatment.

The shadow may aid in determining:

1. The character of the renal incision.
2. The extent of the necessary renal destruction.
3. The position and extent of the parietal incision.

The incision.—The shadow will often forewarn the surgeon that there is no need to drag the kidney out on to the loin. In many cases of small oxalate-of-lime stones of the kidney the renal pelvis may be incised and the stone removed without fear of a sinus resulting. This is the case when there is a small oval or heart-shaped, well-defined shadow near the transverse process of the second or third lumbar vertebræ in a patient who has had fixed loin pain and occasional hæmaturia in sterile or oxalescent urine.

Oxalate stones grow slowly and remain small for years. They sink into the mucous membrane, and being fixed, they do not lead early to back-pressure or secondary infection. The kidney is therefore loosened *in situ*, turned forwards till the hilum is exposed, the pelvis incised over the stone along a line parallel to the ureter under control of the head lamp. The incision heals by first intention.

A single shadow near the mid-vertical line in the centre of the loin space indicates a stone in a dilated calyx. The cortex of the kidney will then need incision over the cystic dilatation found by the exploring finger. The pelvis can also be explored through this incision. If more stones are present they should be removed through fresh incisions made directly over them through the thinned-out cortex.

A triangular shadow in the renal region with a nose pointing downwards with phosphatic urine means ureteric block, pelvic distension, and pelvic infection, and indicates early operative removal of a pelvic stone with drainage before more serious damage to the kidney can occur.

If a stone is dendritic it is certain that the kidney has

suffered severely, and the operator should always be *prepared* for nephrectomy if the urine be phosphatic, purulent, and stinking. Nephrectomy is usually demanded in such cases, as the main mass of the kidney substance has been destroyed and the kidney infected beyond hope of recovery by drainage.

The position of the parietal incision.—If the shadow is clearly that of a ureteric stone the incision employed for exposing the ureter is employed in preference to the lumbar nephrotomy incision.

Visual Fallacies in the Radiography of Renal Calculi.

(1) *Flaws in the plate.*—Flaws in the gelatine of the plates are detected as bubbles while the plate is still wet, or a second plate may be taken in cases of doubt.

(2) *Intestinal contents,* metallic drugs and foreign bodies should be excluded by the routine preliminary vegetable purge.

(3) *Cretaceous fæcal deposits in the appendix.*—Ordinary appendix concretions do not cast a shadow, but rarely they may become calcified, and then they will cast a shadow in the region of the iliac crest.

(4) *Calcareous lumbar glands.*—These may be multiple; the shadows are round or oval, the outline is misty. They are arranged irregularly along the spinal column or along the sharp brim of the true pelvis.

(5) *Patches of calcified tuberculous deposit in a tubercular kidney.*—Tubercular abscesses, ulcer sloughs, fibrous cretified kidney substance.

Other fallacies, especially phleboliths, will be discussed in dealing with ureteric calculi.

It should once again be emphasised that an inflamed kidney full of pus may prevent a large branched phosphatic stone throwing a shadow; though the same stone, if radiographed after removal, will throw a perfect shadow.

Complications.

(1) Pyelonephritis (acute and chronic).
(2) Pyonephrosis.
(3) Perinephric abscess and fistula.
(4) Calculous anuria.
(5) Hydronephrosis.

Acute pyelonephritis may be simple or suppurative. The onset is sudden with rigors, severe pyrexial attack and pyuria. The acute stage subsides in a week or ten days and gives place to a condition of chronic pyelonephritis, with a tendency to acute relapses.

Chronic pyelonephritis runs a variable course. It may last for some years while the patient gets about fairly comfortably, troubled from time to time with slight chills, pains in the back, and increased frequency of micturition, the urine being hazy with pus, which hardly varies from day to day. Both kidneys may be infected and contain stones, which increase in size from deposit of phosphate around them. At length a more acute relapse than usual leads to an operation or the death of the patient, but in some cases the patient gradually wastes, and dies exhausted of chronic uræmia.

Pyonephrosis comes on insidiously or after an attack of acute pyelonephritis. The stone seldom blocks the ureter completely, so that pus is enabled to make its way from time to time down the ureter. The course is marked by attacks of fever during which the urine clears, and the kidney becomes enlarged and tender. After some days the distended kidney empties itself down the ureter, the urine becomes very thick with pus, but the symptoms subside. The kidney may attain an enormous size and yet remain freely movable. After some years the patient is carried off by uræmia or septicæmia.

Perinephritic abscess is not common, and if allowed to burst gives rise to a urinary fistula, so that on rare occasions the stone may be discharged through the fistulous opening.

Calculous anuria is of sufficient importance to demand separate treatment in a section at the end of this chapter.

Hydronephrosis is an uncommon complication of stone (1–2 per cent.) (see Ch. VI).

Diagnosis.

Straightforward cases are the exception rather than the rule, the majority presenting themselves for diagnosis as cases of *obscure pain, hæmaturia, or pyuria.* The routine employment of the X rays when any of these symptoms are found enables a definite decision to be made.

Fixed renal pain caused by stone must be distinguished from—

1. *Pain caused by diseases of other parts,* such as "lumbago," spinal caries, aneurysm, tumours of the spinal cord and

column, and of the retro-peritoneal structures, especially of the juxta-aortic lymphatic glands.

2. *Pain caused by other diseases of the kidney*: pyelonephritis, tuberculous nephritis, chronic interstitial nephritis, and the back-pressure kidneys of urethral obstruction.

A complete investigation of the patient, bearing these possibilities in mind, should enable the above to be excluded.

Patients aged from twenty-five to forty-five, suffering from chronic interstitial nephritis, are met with who suffer from attacks of continuous renal pain and profuse hæmaturia. The pain is seldom severe, and may be absent for months together; it is usually bilateral, and bears no relation to movement. The hæmaturia bears no relation to the pain, and is very profuse. A history of scarlatinal or other acute nephritis in youth is often to be elicited, and there are well-marked cardio-vascular changes, the systolic blood-pressure being raised to 160–200 millimetres of mercury, as measured in the brachial artery.

The Diagnosis of Renal Colic caused by Stone from that caused by Other Pathological Changes in the Uro-genital Tract.

Renal colic is produced by anything which obstructs the free flow of urine through the pelvis and ureter, and is due to painful contractions of their muscle wall. Such obstruction may arise from changes within the lumen, changes in the wall, changes without the wall.

1. *Changes within the lumen.*—Foreign bodies, including calculus, crystals, blood-clot, curds of pus, sloughs of ulcers, portions of growth, and gross parasites, such as hydatid cysts.

2. *Changes in the wall* are strictures of the ureter, congenital or acquired.

3. *Changes outside the wall* are kinks, bands, abnormal vessels, and the pressure of tumours.

If a complete physical examination be made (see Ch. I, Sect. I), with this table in mind, it is seldom impossible to determine the cause of the colic, the commonest causes being calculus, movable kidney, tuberculous kidney, neoplasm, pelvic tumour, and abnormalities of the ureter.

A calculus is suspected if there is a previous history of intermittent colics for some years, *followed* by smoky urine and brought on by sudden movements, and of the passage of

gravel. If the kidney on the affected side is not enlarged during the colic the most likely cause is a stone, and a family history of stone or gout is suggestive. The diagnosis is confirmed by X-ray examination.

A movable kidney is diagnosed by abdominal palpation; a tuberculous kidney by the finding of tubercle bacilli and pus cells in the urine issuing from the ureter, and by the presence of other tuberculous lesions; pelvic tumours by rectal and vaginal examination; abnormalities of the ureter by ureteric soundings and by exploratory operation.

In renal neoplasm the history is much shorter, and the course more rapid; hæmaturia is usually the onset symptom, is bright and profuse, bears no relation to movement, and is *followed* by clot-colic. The presence of an enlarged kidney, and a varicocele on the affected side, if noticeable, will confirm the diagnosis.

A patient who is passing any variety of gravel may complain of renal pain, increased frequency of micturition, and even slight hæmaturia. The X ray is negative, and the symptoms disappear when the urine becomes clear.

In chronic malaria spasmodic attacks of renal pain and hæmaturia are not uncommon. The history supplies a ready clue to the cause and the treatment.

The Diagnosis of Renal Colic from other Severe Abdominal Crises.

There is only a difficulty in the exceptional case. The diagnosis is made by a careful consideration of the whole case after a complete examination, oral and physical, bearing in mind the other conditions which can give rise to sudden severe abdominal pain.

Causes of Sudden Severe Abdominal Pain.

1. *Colics,* renal, biliary, appendicular, intestinal (lead, ptomaines, ingesta).
2. *Twists,* movable kidney, ovarian cyst, fibroid, intestine.
3. *Intestinal obstructions.*
4. *Hæmorrhages, e. g.* ruptured ectopic, pancreatic, purpuras.
5. *Perforation of a viscus and peritonitis,* stomach, appendix, intestine, gall-bladder, etc.
6. *Neuropathic.* Tabetic crises, intercostal neuritis.
7. *Acute pleurisy.*

8. *Accidents to vessels.* Emboli; angina of splanchnic arteries.

If no change in the urine can be detected throughout the crisis then the condition is certainly not renal. If strangury is present it is diagnostic, but in a certain number of cases it is absent, and if there be hæmaturia attention is at once called to the urinary tract. When both these are absent the previous history will often supply a clue, and if this fails a tender testicle may be a sufficient guide; but failing these the course of the case should be watched. The colics recur for some hours, and then all pain passes away rather rapidly, the temperature returning to normal and remaining there, as opposed to cases of peritonitis where the early severe pain soon passes away and is replaced by a *continuous* dull pain which increases in severity, and the temperature rises from subnormal to 102° F. or 103° F., accompanied by other pyrexial signs. The vomiting is seldom copious as in intestinal obstruction, though oft repeated, and is never "fæculent," and diarrhœa is the rule rather than absolute constipation. Lead colic is discovered from the occupation and an examination of the gums; a tabetic crisis by examination of the nervous system.

In gall-stone colic, if jaundice is absent, the gall-bladder not enlarged, and no gall-stones have ever been passed, the character of the pain often affords a clue. It is felt in front higher up in the hypogastrium under the margins of the ribs, and when it travels backwards it is felt in the shoulder-blades and mid-dorsal region. Deep tenderness is not present behind in the costo-vertebral angle, but is found in front by dipping in beneath the edge of the line at the top of the ninth rib. The two conditions may co-exist.

Relapsing appendicitis.—The far more frequent occurrence of this affection, the position of the pain and deep tenderness in the right iliac fossa, and its absence in the back of the loin (except in extra cæcal cases), the common occurrence of slight palpable thickening round the appendix, and finally the absence of urinary symptoms and a negative radiogram are sufficient guides.

Acute pleurisies may come on suddenly while the patient is at work, and the pain be reflected to the abdomen through the lower intercostal nerves. Points of deep tenderness appear along the outer border of the rectus where the nerve trunks enter the muscle. The immobility of the chest on the affected side, the rapid, restrained breathing, and the

absence of urinary symptoms usually suffices to distinguish the complaint.

It may be repeated once more that all cases of *obscure* one-sided pain in the back, abdomen, or legs should be submitted to a complete X-ray examination.

Painless hæmaturia is a rare symptom of a buried oxalate calculus; the X rays at once reveal the true cause and distinguish it from cases of bleeding neoplasm and granular kidney.

If the clear urine passed by patients with stones be centrifugalised, and the sediment examined microscopically, red blood-corpuscles can often be discovered, especially in the urine passed after the day's work is over. *Crystals* may be completely absent from the urine of patients with stone, and may be present as gravel when there is no stone, so that little reliance can be placed upon them.

In making a diagnosis certain questions should always be asked and answered with respect to the affected kidney. Is it aseptic or infected? Is it of normal size? Is it atrophied and shrunken? Is it distended and dilated with urine or pus?

Attention must be paid to the state of the opposite kidney. Is it hypertrophied? Is it in a state of chronic nephritis? Does it contain stones? Is it infected or dilated with urine or pus? The X ray and the ureteric catheters should be employed to determine its functional state before any intervention is practised on the opposite kidney.

If the first radiogram is negative it is sometimes worth while to repeat the process, but uratic stones too small to show will usually be passed naturally, so that secondary phosphatic stones in a pelvis full of pus are the only ones likely to be missed for long. If nothing can be found to account for well-marked symptoms an exploratory nephrotomy will often do good, even if it fails to reveal a stone. Exploration of the upper end of the ureter may reveal many abnormalities which can simulate the symptoms of stone, and when these are absent decapsulation of the painful kidney which relaxes intra-renal tension is found in practice to relieve the pain in most cases.

Prognosis.

A patient with a renal calculus is living, as it were, on the edge of a precipice, since at any moment he may be seized

with a colic, which in itself is seldom if ever fatal; but meantime the stone is slowly working the destruction of a part or the whole of one kidney, more rapidly when there is obstruction to the outflow of urine, and in a few weeks or months when infection has occurred. The patient may live for years if the disease remains confined to one kidney, but the appearance of stone, infection or reflex anuria in the other kidney may at any time end the struggle. *The risks of carrying a stone are such as to justify an attempt to remove it in all cases, no matter how quiescent at the time of diagnosis.*

In "oxalate" cases the prognosis is excellent, as the disease is local, is seldom bilateral, the onset of obstruction and infection is late, the operation simple and aseptic, and the disease is unlikely to recur. The same is true of primary phosphatic cases.

In "uric acid" cases the prognosis is less favourable, as the disease is a general defect of metabolism, is often bilateral, and may affect the whole of both kidneys; obstruction occurs early, though infection late; the diagnosis by X rays is more difficult, the operation required is more extensive, and it is hard to be certain of removing all the stones. At the same time the natural passage of showers of tiny uric acid stones is not uncommon, and is compatible with a long and useful life.

In secondary phosphatic cases the outlook is seldom good, since the presence of such stones indicates that the kidney has already become deeply infected and largely destroyed. If the other kidney is healthy, and nephrectomy can be practised, all may yet be well and a cure be obtained, but too often the other kidney is also infected and contains similar stones, in which case little can be expected save an early demise at the most in a few years, at the least in a few months.

The prognosis is much influenced by the line of treatment. In modern practice the same principles hold as in dealing with appendicitis. *A diagnosis once made the stone should be removed by operation, if possible during a quiescent period, unless it is thought likely that the stone will pass naturally in a few months' time.* Nephro-lithotomy practised early on aseptic cases has no greater mortality than the operation of nephropexy and "interval" appendicectomy, and complete cure can be confidently expected without fistula. If expectant treatment be adopted the patient is bound to require an operation sooner or later under more unfavourable

circumstances, when infection or back-pressure have minimised the power of the kidneys. Nephrectomy or nephrostomy will then have to be performed, with their much higher mortality (20—30 per cent.), and the chance that if successful a permanent renal fistula will be left to render life unbearable.

If no operation be performed the patient is certain to succumb after months or years to such complications as uræmia, calculous anuria, pyelonephritis, pyonephrosis, amyloid disease, septicæmia, perinephritis, fistula, hæmorrhage, or peritonitis.

Treatment.

Prophylaxis.

Certain rules of life may be laid down for those who suffer from "gravel," and for those who have already had a nephrolithotomy, and who wish to avoid further trouble.

1. *For those who pass uric acid "gravel" or have suffered with uric acid stones.*

The objects are—

1. To diminish the in-take of the sources of "exogenous" uric acid.

2. To increase the solvent action of the urine upon uric acid by diminishing the acidity, and increasing the sodium chloride content.

3. To influence the formation of excess of "endogenous" uric acid.

The diet.—The nucleins of the food are the source of exogenous uric acid, *not* the proteins. Cellular organs, such as liver, sweetbread and kidney; meat extracts; tea, coffee, and cocoa, all give rise to uric acid, and must be limited in use. Meat obtained from muscle substance is less harmful, and there is a prejudice for the white meats. Eggs, milk, and cheese are nuclein free, so that they can be eaten freely.

Nothing certain is known of the influence of diet on the endogenous uric acid which is produced in excess in gout. Empirically it appears that *excess* of sugar and fat are not suited to gouty subjects.

Small choice meals should be ordered, selecting from lean of meat, poultry, game, fresh fish; eggs, milk, and cheese, moderate amounts of starchy foods can be added, and also plenty of fruit and vegetables with the object of alkalinising the urine, but sugar should be cut down to a minimum.

Table salt helps to keep the uric acid in solution in the urine, but it throws more work on the kidneys.

Drink.—Copious flushing of the urinary tract by the intake of plenty of plain water should be encouraged, especially with alkaline waters of low salt content, such as Contréxeville, Vittel, Vichy, potash, lithia and magnesia waters, and aërated distilled water such as Salutaris and Puralis. Excess of alcohol and especially the *heavy sweet* wines must be avoided, such as port and sherry, but digestion may be aided by the moderate use of very dry champagne, light claret, Moselle, or a light dry cider.

The general hygiene of the body must receive attention. The vicarious action of the skin and bowel must be encouraged, the bowel being kept clear because of the risks of hæmatogenous renal infection and to diminish intestinal toxæmia. The skin is kept clean by regular bathings and friction with a rough towel, and perspiration encouraged by exercise or by Turkish baths.

Regular exercise in the open air of the more moderate varieties must be insisted upon in those who lead sedentary lives. As Bacon wrote: "Bowling is good for the stone and reines"—an admirable picture of the kind of moderate, steady exercise required.

Drugs.—Certain drugs can be used to increase the solubility of uric acid by rendering the urine alkaline, and encouraging the formation of potassium and lithia salts of uric acid, which are more soluble than the sodium salts.

Potassium citrate in doses of 30–60 gr. four times a day is of undoubted value, or the carbonates and citrates of lithium and magnesium may be substituted, and boracite of magnesia, in drachm doses, has been warmly recommended.

Piperazin and piperidin form soluble compounds with uric acid, and are a favourite remedy.

If it is thought undesirable to keep the urine alkaline because of the risk of infection, certain acidising drugs may be used, such as benzoate of ammonia, which turns the uric acid into the more soluble hippuric acid, or piperazin and urotropin, which also dissolve uric acid.

Quinic acid is said to diminish the endogenous production of uric acid, and is contained in the patent preparations, sidonal and urosine, but it is doubtful whether this is a desirable liberty to take with the metabolism of gouty tissues.

2. *For those who suffer from oxaluria.*

The principles of treatment are as follows:

(1) The free use of diluent waters that must be calcium-free.

(2) Limitation of the oxalate and calcium content of the food.

(3) The treatment of the hyper-acid dyspepsia often present.

(4) The limitation of the nucleins in the food.

It is uncertain whether the oxalate crystals are derived from the oxalates in the food or from the katabolism of the endogenous uric acid, since experimenters differ as to the results on the urine of feeding animals and men on oxalate-free diet, some finding that no effect is produced by way of diminution or increase. It appears that oxalates are kept in solution in the urine by the magnesium and sodium phosphates, and diminution of calcium salts in the food is thought to diminish the chance of calcium oxalate being excreted in the urine. The treatment is therefore very similar to that of uric acid gravel, with the addition that calcium and oxalic acid are also excluded as far as possible from the dietary.

Diet.—(1) *The oxalate intake is diminished.* Articles rich in oxalic acid are rhubarb, spinach, sorrel, tea, cocoa, pepper.

(2) *Fluids rich in magnesium and sodium phosphates are encouraged.* Kissingen and Hunyadi water are rich in these salts, and citrate of magnesia and acid sodium phosphate may be ordered as drugs.

(3) *Food rich in calcium is discouraged.* Milk is rich in calcium (but can be "citrated" by the addition of sodium citrate, a grain to the ounce, which precipitates the calcium salts), as are eggs and many fruits and vegetables, especially cabbages, rice, asparagus, spinach, and radishes. Apples are calcium free and are therefore favourable, and cider has been much lauded as a preventer of the stone. Bread, fish, meat and potatoes are poor in calcium content.

If the drinking water is obtained from a chalky or limestone soil its use should be discouraged. Lime-containing mineral waters are Apollinaris, Rosbach, Johannis and Kronthal. Mineral waters poor in lime are Contréxeville, Vichy, and Vittel.

The dyspepsia is controlled by the exhibition of mineral acids before meals, or alkalies after meals, and a course of the bitter tonics, such as nux vomica and quinine, is often of value. Worry and overwork require correction.

3. *Primary phosphatic cases* (*calcium phosphate*).

The indications are to render the urine strongly acid by

acid sodium phosphate or dilute nitro-hydrochloric acid; to limit the vegetarian diet which is usually being employed and increase the animal food.

The Treatment of Renal Colic.

Renal colic is seldom fatal unless it is followed by anuria, so that the object is to tide the patient over his attack, when a more complete examination can be made and further treatment considered. The painful spasms of the ureter can be relieved by means of very hot baths, and the exhibition of morphia and belladonna in suitable doses, but if the pain cannot be controlled chloroform may be used. Sometimes the attack is terminated abruptly by the expulsion of the stone.

Treatment apart from Severe Colic.

The nature of the stone as determined by the X rays determines the lines of treatment.

Stones Present in One Kidney Only.

1. *A Single Oxalate Stone or a Primary Calcium Phosphate Stone in Aseptic Urine.*

There is no immediate hurry to remove the stone as the kidney is neither blocked nor infected, yet natural passage is very unlikely, and eventually the stone will destroy the patient's kidney, so that an early nephro-lithotomy is the only possible course, and presents little, if any, risk.

2. *Smooth Multiple Uric Acid (and Mixed Oxalate) Stones.*

Such stones are frequently got rid of by the natural channels, but at other times they are apt to plug the ureter and lead to atrophy of the kidney after three to six months. A chance should therefore be given them to pass naturally during a period of at the least three, at the most six months. Copious diuresis is encouraged by the use of Contréxeville water, and the patient is tided over his attacks of colic, encouraged by the stones that may come to hand after each attack.

If after six months there is failure to expel all the stones, nephrolithotomy should be urged, but the operation will be difficult, and the results not so good as in dealing with oxalate calculi.

There is one type of patient, old, active, and gouty, who passes innumerable uric acid calculi no larger than a pin's head at intervals with severe colic. If the X rays show no shadow no large stones are likely to be present, so that an operation is not likely to be of service.

3. *Secondary Phosphatic Calculi.*

The kidney is severely infected, and in process of rapid destruction, so that there is no time to waste. *Nevertheless the patient should be kept for ten days in bed on a fluid diet, dosed with urotropin and acid sodium phosphate, and the bowel thoroughly cleared.* In this way not only are the bacteria diminished in number and virulence, and the patient rendered more immune, but also the excretory power of both kidneys is much improved. The functional power of the unaffected kidney must be determined before operation, and the kidney is explored on the understanding that nephrectomy may be required, though if the urine be not very foul and there appears to be a moderate amount of healthy kidney substance left, and there are no groups of isolated abscesses in the kidney substance, then a preliminary drainage may be instituted to give the kidney a chance to heal; but too often a fistula persists, and necessitates a secondary nephrectomy.

If Stones are Present in Both Kidneys.

In uric acid cases nephro-lithotomy is practised on one kidney at a time, leaving an interval of two or three weeks in between, the kidney most depressed in function being attacked first. In secondary phosphatic cases the outlook is grave, though the pyelitis is usually of the chronic type. Nephrotomy should be practised on one kidney, and the stones removed and drainage instituted. If the patient stands the operation well, and the kidney shows signs of healing, some weeks later the opposite kidney is exposed, the stones removed and drainage established. In some cases the infection may clear up if energetic treatment be maintained by means of urinary antiseptics, free diuresis, and attempts to immunise the patient to the infecting bacteria; but in many

cases these measures fail, and a recurrence of the stones takes place in six months to a year, when a second operation may be attempted if the patient is fit to stand it; but in any case such an operation only puts off the fatal day for a short time. These cases of chronic bilateral pyelitis with formation of phosphatic stones are the most difficult to cure with the present means at our disposal, as neither drainage, lavage, nor serum-therapy seem to have much influence in removing the infecting organism, though if the organism can be got rid of the stones cease to form.

OPERATION may be imperative, advisable, or unnecessary.

1. *Imperative*:
   (*a*) Calculous anuria.
   (*b*) Acute and chronic pyelo-nephritis and pyonephrosis.
   (*c*) Complete blockage of one ureter.
   (*d*) To stop hæmorrhage in rare cases of persistent hæmaturia.
2. *Advisable if the patient consents*:
   (*a*) An oxalate stone shown by the X rays in aseptic urine and causing little trouble, the small risks of the operation being weighed against the heavy risks of leaving such a stone.
   (*b*) Useless colics that produce no effect on the stone
   (*c*) Constant aching pain that renders life miserable.
3. *Unnecessary*:
   (*a*) Cases of repeated colics during which tiny uric acid stones are always passed and in which the X ray shows no shadow.
   (*b*) A small, mixed uratic stone that has entered the ureter and should be given three months' "internal" treatment to await natural passage, this process being followed by repeated X-ray examinations. In these cases it is sometimes possible to hasten the passage of the stone by dilatation of the ureter below the stone by means of ureteric bougies, and by the injection of olive oil through a ureteric catheter.

The operations practised for renal calculus are:

1. *Nephro-lithotomy and pyelo-lithotomy.*
2. *Nephrotomy and pyelotomy*; with drainage (*nephrostomy, nephrotresis*); with secondary nephrectomy.
3. *Primary nephrectomy.*

The kidney is always approached by the lumbar route, as the transperitoneal path is attended with too great a risk to the peritoneum, if the kidney happens to be infected, and even the largest pyonephrosis can be removed by the lumbar route after it has been emptied by tapping in the course of the operation.

Nephrotomy with drainage is seldom required at the present day, owing to the X rays and modern methods of "function" diagnosis, as it is only needed for neglected cases, whereas the diagnosis is now made early in the course of the disease, and a clean nephro-lithotomy performed. The kidney is not allowed to reach the stage of infection when nephrotomy with drainage becomes an unfortunate necessity, and the risks of a permanent renal fistula greatly increased. This risk of fistula, and the fact that nephrotomy with drainage is only performed when the patient's condition is already sufficiently serious, so that the mortality after this operation is high (20 per cent.), have brought the operation into disfavour, but this should not prevent the surgeon from resorting to it in suitable cases. Modern methods of estimating the capacity of each kidney may make the surgeon too ready to excise an infected kidney when he knows the other kidney is sound, so as to obtain a first-intention wound, but it is as well to give the kidney a chance of recovery, if it is in a condition of mild pyelonephritis rather than of advanced suppurative pyonephrosis. Each case must be treated on its merits and judged by the condition found at operation.

1. *Nephro-lithotomy and pyelo-lithotomy.*

The kidney is approached by the lumbar extra-peritoneal route. It is cleared from its bed of fat and turned forwards into the wound so as to expose the hilum and upper end of the ureter, and avoid the vessels which lie mainly in front. If there is a single oxalate stone in the pelvis an incision is made directly on to the stone through the pelvic wall, in a line parallel to the direction of the ureter under the control of the head lamp, the stone removed, the pelvis stitched up with fine catgut, a small indiarubber drainage-tube left in the wound leading to the surface, and the rest of the wound closed. Healing should be by first intention.

If the stones are multiple, and lying in the calices, the surface of the cortex is examined for areas of dimpling which reveal cysts, at the bottom of which the stones are lying. Small longitudinal incisions are made into these areas, the finger inserted, and the stones removed. The

pelvis and the mouths of the other calices can be explored with the finger through the holes thus made, and as nearly all stones lie in the calices or pelvis a stone is not likely to be missed. The "post-mortem cut" splitting the whole cortex is seldom required, but if made it should be through the "bloodless line" of Hyrtl and Max Broedel.

A bougie should always be passed down the ureter to the bladder to make certain that the ureter is clear. If phosphatic branched calculi are present the kidney is incised directly over them, and peeled off the stones, which are very liable to break up during removal, so that portions might get left behind; drainage of the pelvis must be established, and suppuration will occur in the wound. For these reasons a nephrectomy without opening the kidney at all is often the best operation if the kidney is known to be functionless. Needling is seldom if ever required at the present day.

The mortality of nephro-lithotomy, taken from a large number of cases operated on since the use of the X ray and modern "function" diagnosis methods, is given by Garré as 3–4 per cent.

2. *Nephrotomy and pyelotomy* with drainage and lavage are performed for infected cases, the stones being removed at the same time, but a permanent fistula is left in 30 per cent. of the cases. Secondary nephrectomy is required, the functional power of the other kidney having been found to be sufficient, if the fistula refuses to close and life becomes unbearable from the persistent urinary dribble on to the loin; but it is always a difficult operation because of the dense adhesions that bind the kidney, and is attended with a higher mortality than primary nephrectomy.

3. *Primary nephrectomy* is only possible when the state of the other kidney is known to be healthy, and is performed for advanced cases of pyonephrosis, care being exercised to avoid soiling the wound or the peritoneum with the pus, so that rapid healing may be obtained. The mortality for this operation is still between 20 and 30 per cent.

CALCULOUS ANURIA.

Causes.

A. The Affected Kidney.

(1) *Sudden plugging of the ureter* by a stone in a comparatively healthy kidney.

(2) *Sudden failure of compensation* in a hypertrophied

kidney, which has for a long time been subject to the irritative effects of stone.

B. THE OPPOSITE KIDNEY IS—

(1) *Absent.*
(2) *Functionless* from disease.
(3) *Depressed in function* from disease (stone, infection, etc.).
(4) *Also blocked by a calculus* (rare).
(5) *Practically healthy* (very rare).

In the large majority of cases the opposite kidney is the one most diseased, even if it be not completely obsolete or absent, so that its small remaining power of secretion is easily knocked out by reflex causes, and only some half dozen cases are on record where it was found to be healthy. The affected kidney always shows signs of hypertrophy—evidence that it was the last to become affected, and was struggling to carry on the work of the body.

Morbid Anatomy.

The affected kidney contains a stone blocking the ureter, or contains stones in the pelvis and calices, which have led to advanced destruction of the renal tissue by fibrosis and suppuration. It is large and congested, and may be in a condition of pyonephrosis, or rarely of hydronephrosis.

The opposite kidney may be absent, may be a small, shrunken, atrophic fibrous shell, or show evidence of disease such as toxic or infective nephritis, cystic disease, new growth, etc.

Clinical Signs and Symptoms.

The type of patient usually affected is a stout, middle-aged, gouty male, but the disease may occur at any age, even in quite young children, and in the female sex. There is often a history of previous attacks of renal colic, hæmaturia, and the passage of stones; but many cases are met with who have never suffered with any previous sign or symptom. The onset is usually sudden, and may be induced by any sudden movement, and is ushered in by pain in one kidney, or by an attack of renal colic; but sometimes the onset is insidious and almost painless, the patient remaining at work till the strangeness of passing no water at all induces him to seek advice. Strangury is a common feature.

The course of the disease differs from other forms of anuria and is divided into two periods:

(1) *The tolerant period.*
(2) *The uræmic period.*

(1) The Tolerant Period.

The patient can get about and do his work, unless he be confined to bed by an onset with severe colic, which passes off in a few hours, and save for the fact that no urine is passed nothing would be thought to be amiss, and the only symptoms likely to be present are debility, sleeplessness, and a feeling of nausea.

When hydronephrosis exists the anuria is sometimes incomplete, intermittent attacks of polyuria occurring, the urine passed being pale, of low specific gravity, and faintly albuminous. The tolerant period lasts eight to ten days in the ordinary case, but in the cases with hydronephrosis and polyuria it has been prolonged to twenty or even thirty days.

(2) The Period of Delayed Uræmia.

Only a few of the ordinary uræmic signs are present. The temperature drops to 96·5–97·5° F., and the pulse is slow and drops a beat now and again. The patient lies in a dreamy calm, wholly indifferent to the seriousness of his state; he sleeps a great deal, but can be roused and be made to answer questions intelligently; from time to time he vomits, but not more than once or twice in the twenty-four hours. The hands twitch restlessly during sleep and waking, the pupils may be contracted, there is copious sweating, and the bowels are confined and distended with flatus. Œdema is rarely seen.

The end comes in two or three days; either the circulation fails and œdema of the lungs drowns the patient in a copious frothy, blood-stained pulmonary secretion, or coma preceded by convulsions leads to a quiet ending.

Spontaneous recovery takes place in 28 per cent. of the cases according to Legueu, the stones being passed or retained, and is marked by sudden polyuria and the passage of pale urine of low density and containing a trace of albumen, a polyuria which lasts for days. All the symptoms disappear for the time being, but at any moment they may recur if no operation be performed. The course thus differs markedly

from that of anuria due to non-obstructive causes, in which death occurs in two to four days, signs of uræmia appear earlier, and recovery is marked by the passage of scanty urine, blood-stained, and highly albuminous.

Diagnosis.

The diagnosis is made by the fact that the patient passes no water, yet the bladder is not distended, and the passage of a catheter reveals the fact that the bladder is empty.

The diagnosis has then to be made from the other causes of anuria.

CAUSES OF ANURIA.

(1) *Obstructive.*

Calculus.
Pelvic tumour.

(2) *Non-obstructive.*

A. Neuropathic.
  1. Reflex. Instrumentation of urethra and bladder. Operations on any part attended by shock. Severe trauma to one kidney.
  2. Hysteria.

B. Advanced disease of kidneys:
  1. Toxic nephritis, acute and chronic;
  2. Microbic nephritis;
  3. Neoplasms and cysts.

In calculous anuria.—The history of previous attacks of colic, gravel, and stone, are diagnostic if present. The affected kidney is usually enlarged and tender, and rectal and vaginal examination may reveal an impacted calculus. An immediate X-ray examination is imperative, and the cystoscope will often reveal that one ureteric mouth is absent, or patent and dragged out—a sign that the corresponding kidney is shrunken and functionless—and the other ureteric mouth is puffy and inflamed owing to the impacted calculus. The passage of ureteric bougies will reveal the presence and position of the ureteric block.

Pelvic tumour.—Carcinoma of the uterus is a more common cause of anuria even than calculus, which is uncommon as a cause in women, and can be excluded by vaginal and rectal examination.

The reflex anurias associated with instrumentation, operation and rupture of the kidney, are evident from the history.

Hysterical cases sometimes occur in young women; the general state of the patient and the complete absence of any signs of disease in the urogenital tract after a complete examination is sufficient for diagnosis.

Anuria is a terminal symptom of double ascending suppurative pyelonephritis in patients who suffer with neglected stricture or enlarged prostate. Routine examination reveals their presence and the fact that the course of the disease is ushered in by a well-marked pyrexial attack with rigors, and the patient has been ill for some time before the onset of the anuria, which does not come on *suddenly,* but is *preceded by a period of oliguria.*

In the case of an acute attack of inflammation on a chronic toxic nephritis (Bright's disease) a few ounces of urine have generally been obtained before the onset of complete anuria, which is blood-stained, highly albuminous, and contains many casts; œdema may be a marked feature, and the history, the fundi, the raised arterial tension and the early and more intense uræmic symptoms are sufficiently characteristic.

Prognosis.

Without operation death occurs in 50 to 70 per cent. of the cases; with operation the mortality is reduced to 20 per cent. In those rare cases where the stone is not blocking the ureter, but is lying in the calices or pelvis, little benefit can be expected from operation, as the renal substance has reached the limit of its endurance, and there is no obstruction to relieve.

Treatment.

An operation should be undertaken immediately the diagnosis is certain, the object being to secure a free outlet for the passage of urine with as little disturbance as possible. Prolonged operation produces shock, and the lowered blood-pressure associated therewith may delay the return of free renal secretion, for which reason extraction of the stone is deferred to a later period, unless it can be got at easily without adding to the length of the operation—that is to say, if it is in the upper three or four inches of the ureter, or at its extreme lower end.

The kidney last affected is the one to attack, that is to say, the

kidney which is enlarged and tender on the side of the colic and pain; but the X rays, the cystoscope, and the ureteric catheters will enable a decision to be taken as to this point in doubtful cases. If after all methods of examination doubt still remains, a rapid exposure and drainage of both kidneys is permissible. The kidney is exposed by the lumbar route, the pelvis opened, and a tube inserted, leading to the surface of the wound, any accessible stone being removed at the same time (see also Ch. XII, Sect. I).

CHAPTER VI.

NEPHRECTASIS OR URONEPHROSIS. HYDRONEPHROSIS AND PYONEPHROSIS.

Definitions.

THE terms "uronephrosis" or "nephrectasis" are applied to the slow accumulation of urine under tension which distends and destroys the pelvis and kidney, and is caused by *partial* obstruction to the urinary outflow from obstacles arising in or around the ureter, bladder, or urethra. This urine may long remain aseptic, *hydronephrosis*; or it may become infected with organisms, *pyonephrosis* (see also Ch. VII).

Ætiology.

CAUSES ARE CONGENITAL OR ACQUIRED.

A "*congenital*" condition means a true germinal "sport" or "mutation" of the urinary passages, which may cause hydronephrosis to appear before birth, or may not make its effects felt for years after birth. Congenital cases can therefore manifest themselves at any period of life. It is becoming yearly more evident how important a *rôle* is played by these "congenital sports" on diseases of the kidney, and especially in hydronephrosis (see Ch. II). *The great majority of cases of unilateral hydronephrosis are of congenital origin.*

"*Acquired*" causes act upon healthy urinary passages derived from a healthy germ-cell.

It may be stated as a general rule, to which, however, there are exceptions, that *partial* blockage of the ureter leads to hydronephrosis, *complete* blockage to simple atrophy.

Causes of Nephrectasis.

1. *Congenital.*

(*a*) *Præputial.*	Pinhole foreskin	Bilateral, urgent, requires early relief.
(*b*) *Urethral.*	Pinhole meatus (often combined with hypospadias)	
	Imperforate urethra	
	Stricture	
	Valve	
	Diverticula	
(*c*) *Bladder.*	Congenital septa	
(*d*) *Uretero-pelvic* — In wall	Strictures	Unilateral, less urgent, yet early relief advisable.
	Strictures combined with abnormal attachments, or with double ureter	
	Valves	
	Kinks and twists	
Outside wall	Aberrant blood-vessels	
	Congenital cases of movable kidneys	

2. *Acquired.*

(*a*)	Urethral strictures and obstructions	Bilateral.
(*b*)	Enlarged prostate	
(*c*)	Hypertrophic bladder of increased frequency (H. Morris)	
(*d*) Uretero-pelvic	(1) within lumen. Stones and foreign bodies	Unilateral or bilateral.
	(2) In the walls. Stenosis from ulceration and rupture	
	(3) Outside. Movable kidney, peri-ureteritis, pelvic and abdominal tumours	

If the development of the ureter be considered (see Ch. II) it will be found that in fœtal life the lumen of the ureter is narrowed considerably at its junctions with the pelvis and with the bladder. The lumen also presents numerous valvular folds and spiral infoldings of the mucous and muscular coats, which tend to disappear shortly after birth in healthy subjects, but if they persist they form congenital strictures or valves and lead to hydronephrosis.

The twist that the primitive kidney makes from a sagittal to a coronal plane when it has reached its second position in the loin after its ascent from the pelvis, also throws light on some of the cases of kinks and twists (see p. 23).

The renal blood-vessels spring from the aorta and invade

the primitive kidney when it has reached the loin. Aberrant tail arteries passing *behind* the ureter are met with, and may of themselves be sufficient to cause hydronephrosis, but they are often combined with other congenital abnormalities, such as valves or strictures, and become merely aggravating causes.

The kidney may be congenitally displaced and mobile, its vessels either being too long, or else being inserted too low down the aorta as compared with the opposite side. In this way kinkings of the ureter may arise, or such displacements may be combined with other congenital causes of hydronephrosis.

Acquired movable kidney may give rise to hydronephrosis according to Tuffier. The ureter must remain fixed, to explain which some invoke inflammation from pyelitis as a cause, but then it should also fix the pelvis and kidney; some invoke an anatomical arrangement of the perinephric fascia, which we find hard to demonstrate. The ureter is supposed to become slightly kinked and the pelvis distended with fluid. The more the pelvis becomes distended the more does it press on the ureter and block it. The lower part of the distended pelvis sags, and the ureter thus appears to open into the pelvis high up about its middle portion, and a valve-like arrangement is at length formed. This explanation is ingenious, but the condition is probably congenital, and the kidney becomes "movable" or apparently more movable from its increased size. Subcutaneous rupture of the ureter from a blow leads to extravasation of blood and urine into the loin, which is not to be mistaken for a hydronephrosis, but months later a stricture may occur at the site of the rupture and cause true hydronephrosis.

Ulcers arise in the ureter as the result of stone irritation, and, showing little tendency to heal, lead to stricture and hydronephrosis.

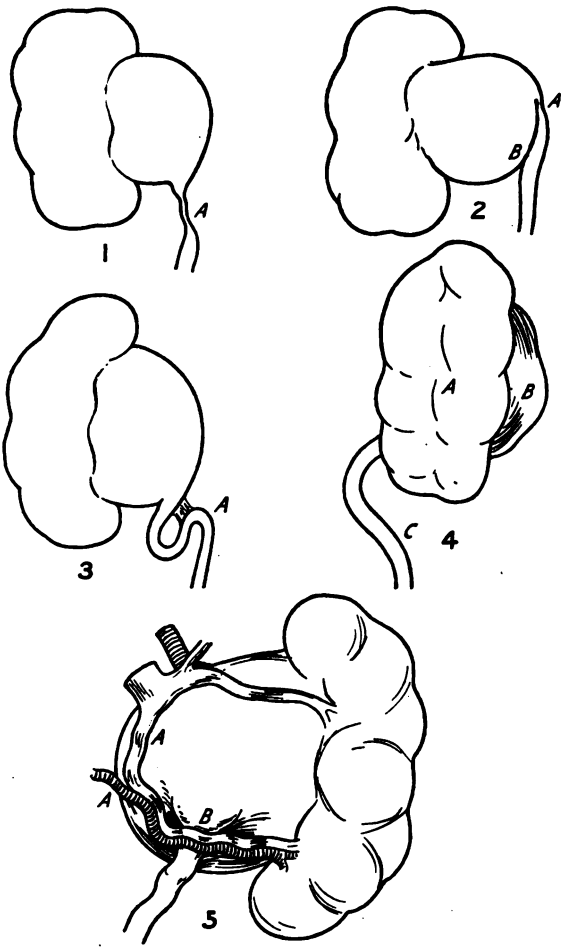
Apart from this method, stones obstructing the ureter may occasionally give rise to hydronephrosis, but more often if they block the ureter for long they lead to complete renal atrophy or pyonephrosis. Stones may also occur as secondary phenomena in congenital hydronephrosis.

Pathology.

Morbid Anatomy.

At first the ureter and pelvis are alone dilated, but sooner or later the kidney substance is thinned out and stretched

A SERIES OF CASES OF CONGENITAL HYDRONEPHROSIS FROM THE LONDON HOSPITAL RECORDS.



1. Congenital stricture (A).
2. Congenital stricture (A), with secondary valve formation from sagging of pelvis (B).
3. Congenital kink (A).
4. Left kidney. Congenital twist. Posterior border (A) looking forwards. Dilated pelvis (B). Ureter (C).
5. Aberrant vessels passing behind ureter and bowstringing the ureter at B.

over the distended calices, until the parenchyma has almost disappeared, and the kidney is represented by a mere shell surrounding loculi of fluid. The surface often appears lobulated, the ten primitive lobules of the fœtal kidney being thus brought into evidence again. The lobulation was held by some authors to be present only in congenital cases, but while strongly suggesting a congenital cause, yet it can appear in acquired cases.

The hydronephrosis may not be larger than a normal kidney, or it may attain gigantic dimensions; Glass reported a case which contained thirty gallons of fluid. The fluid is usually pale and clear, containing minute quantities of urea, uric acid, chlorides and phosphates and so forth, though eventually it may cease to resemble urine in any degree, containing, perhaps, a little chloride and cholesterin. It is usually acid or neutral, and contains a trace of albumen, and is of low specific gravity—1007–1010. It may become turbid, blood-stained, pigmented, purulent, or even colloid. The inner surface of the cyst is smooth and lined by flattened epithelium, unlike a pyonephrosis, which is lined by granulation tissue, and the wall may contain calcareous plaques, which simulate calculi in the X-ray plate.

Only a part of the kidney may be affected, as when there is a bifid ureter, one of which ends in a stricture, or when a stone blocks a single calyx.

A hydronephrosis tends to push other organs aside, and rarely becomes adherent to them; the colon is pushed forwards, but sometimes slips to the outer side.

Histology.

1. There is dilatation of the tubules, with flattening and atrophy of the lining cells, many of which are shed.

2. The cells of the interstitial tissue have multiplied and produced a fibrocellular network filled with round cells around the tubules. Interstitial hæmorrhages will be seen when the blood-vessels have been pressed upon.

3. The tubules have undergone atrophy and many have disappeared, their places being taken by fibrous tissue.

4. Bowman's capsules are at first distended with fluid, and the glomeruli are pushed aside, but finally they become replaced by fibrous tissue and disappear.

Morbid Physiology.

If both kidneys are affected the patient slowly succumbs to uræmia, but it is astonishing how long such a one can live even though the total output of urea and salts from the kidney is profoundly lowered. It was held at one time that if one kidney only was attacked that the other would compensate perfectly by hypertrophy, but it is now known that a single hydronephrosis has a deleterious effect both on the body as a whole and on the opposite kidney. Ligature of one ureter may produce polyuria or anuria in the opposite kidney. An attack of intermittent hydronephrosis accompanied by oliguria is followed by polyuria, which increased urine is found to come from the non-affected kidney. Hypertrophy of the opposite kidney occurs, but it is accompanied by interstitial fibrosis which corresponds very closely to that seen in the affected kidney, so that in this way uræmia is slowly but surely produced by the mere continued presence of a single hydronephrotic kidney.

Several hypotheses are put forward to explain this significant fact. For instance, it is pointed out that the second kidney has to eliminate nearly twice as much of the toxic products of metabolism as it normally should do. Or it is possible that toxic bodies are formed by the dying kidney-cells, which, entering the blood, stimulate the interstitial cells to multiply on both sides.

Clinical Forms.

The latent.
The insidious.
The intermittent.
The hæmaturic.
The pelvic tumour.

1. The Latent Form.

A patient dies of uræmia without any palpable abdominal tumour, and at the autopsy a hydronephrosis is found, single or double.

2. The Insidious Form.

Mild uræmic signs may first bring the patient to the doctor, such as causeless vomiting, thirst, diarrhœa, and headache.

Pain is usually absent, or may consist in a dull ache in one loin caused by the mere drag of the heavy tumour. Mild attacks of uretero-pelvic ("renal") colic may occur.

Routine abdominal palpation may reveal a cystic renal tumour (see below diagnosis and Ch. IV) on one or both sides.

The urine will be found pale and of low specific gravity and to contain a trace of albumen and a few casts.

Rectal examination, which should never be omitted, often reveals—especially in women—some form of pelvic swelling which will satisfactorily account for the condition, or in man an enlarged prostate. If the urethra is proved to be healthy cystoscopy is undertaken to exclude a "median lobe" prostate, and other causes within the bladder. A stricture at the ureteric orifice may be at once determined by the characteristic appearance of ballooning of the ureter.

Ureteric catheters are passed, and may reveal the presence of strictures, stones, or valves in the ureter, and may be made to enter the pelvis of the kidneys and estimate the amount of fluid they each contain, which should not be more than one to two ounces. Sterilised salt solution may be injected into each pelvis and the contents of each noted, and the limits of distensibility without causing pain. In this way dilated pelvis can be diagnosed, and the position of the obstruction in the ureter, but the actual nature of the obstruction is less often evident.

At the same time estimation of the functional capacity of each kidney is made by examination of the separated urine (see Ch. I).

Finally the complete pathological diagnosis of the cause may have to be made by surgical exposure of the ureter, pelvis, and kidney.

3. Intermittent Type.

Clinically this is a very well recognised group, and may occur both in congenital cases and in women with acquired right-sided movable kidney.

The patient should be under observation in the ward, with the daily amount of urine measured and tested, on a fairly stable intake of diet and drink, and equable temperature conditions.

The patient is seized suddenly with a violent attack of sharp lacerating pains in the back and front of the loin, which

radiate down along the linea semilunaris to the internal abdominal ring. This pain differs in no degree from "typical renal colic" (see Ch. V). It is accompanied by vomiting, faintness, and cold sweats.

Examination reveals areas of skin tenderness over the tenth to the twelfth dorsal segmental areas, or areas of deep tenderness along the "deep kidney points" (see Ch. V). A renal tumour is discovered, and if it has been felt before is found to have increased in size, which may be due to increase in its urinous content, or merely to increased vascular engorgement. There is noticeable diminution in the amount of urine passed, perhaps not more than eight or ten ounces in the twenty-four hours, or there may be complete anuria.

Almost as suddenly as it began the pain ceases, perhaps aided by recumbency, or massage, or some postural treatment discovered by the patient, the tumour diminishes in size, and there is a period of polyuria for twenty-four to forty-eight hours.

There is seldom any fever during these attacks, unless the sac is infected, and usually the temperature is subnormal during the period of acute pain.

4. Hæmaturia Type.

The attack is sometimes followed by hæmaturia. This is caused by congestion of the kidney from torsion of its vessels.

Hæmaturia may also be caused by the presence of a stone, or more rarely a papilloma.

5. Pelvic Tumour Type.

Hydronephrosis on one or both sides may be the first, and, indeed, the only symptom of pelvic tumour. Pelvic examination can alone reveal the true site of mischief, and should never be omitted before proceeding to explore a hydronephrosis. For instance, a young man was admitted to the London Hospital with painless hæmaturia and right renal tumour diagnosed renal growth. Routine pelvic examination revealed a sarcoma of the right pelvic bone, and the patient was saved from a useless nephrotomy or even nephrectomy. In women especially is this cause to be kept in mind. In 142 autopsy cases reported by Henry Morris 118 were due to pelvic tumour.

Course.

This is usually of long duration. The patient may remain in good health for many years, occasionally troubled with more or less acute attacks of pain and hæmaturia, and after ten to fifteen years may gradually succumb to uræmia, and die suddenly of complete suppression often brought on by infection of the kidneys, but the attacks may be so severe and occur so often as to lead to operation being sought for.

True torsion with strangulation rarely occurs, but demands instant operative relief.

Spontaneous cure has occurred, either by an incomplete obstruction becoming complete or by rupture of the sac.

Rupture of the sac into the peritoneum usually leads to peritonitis, and demands operative relief, but it is a very rare occurrence.

The chief complications are infection, chronic uræmia, anuria, and rupture.

Diagnosis.

1. *Cases marked by tumour.*
   (*a*) From other abdominal swellings.
   Small, especially from gall-bladder swellings.
   Large, especially from hydatids of liver and kidney, pancreatic, mesenteric, ovarian cysts, splenic tumours, and ascites.
   (*b*) From other renal enlargements.
   Small, those due to calculus, tuberculosis, movable kidney, and cysts.
   Large, pyonephrosis, hydatid cysts, polycystic kidneys, traumatic collection of blood and urine, perirenal abscess.

Characteristically a hydronephrosis comes forwards towards the anterior belly wall out of the loin, and may even encroach beyond the middle line; it is painless, cystic, lobulated, kidney-shaped, rounded, smooth, and may yield the sensation of fluctuation and a fluid thrill. The colon may be seen lying in front of the tumour, or its presence may be demonstrated by percussion. Rarely a very large hydronephrosis will push the colon outward into the loin, so that resonance appears between the erector spinæ and the dulness of the main tumour, making a certain diagnosis impossible apart from exploration.

2. Cases marked by renal colic from the other causes of renal colic, stone, tubercle, clot colic, etc.

3. Cases marked by hæmaturia from other causes of hæmaturia (see Ch. XIV).

4. Insidious or latent cases from "granular kidney."

Prognosis.

If the disease is unilateral, and an early diagnosis is made followed by adequate treatment and removal of the cause, the patient can be cured. If the disease is unilateral but the diagnosis is late, the prospects of prolonged life depend on the state of the opposite kidney as determined by various tests. If the disease is bilateral it may be possible to remove the cause, such as stricture of the urethra, or enlarged prostate, but too often irreparable damage has been done to permit of complete restoration of kidney function, and there is ever present the risk of secondary infection which may cut life short at any time. Bilateral hydronephrosis in which the obstruction cannot be removed is inevitably fatal after some months or years from uræmia or secondary infection. Spontaneous cure is very rare and should never be counted upon, the only hope of cure being early operation.

Treatment.

Tapping should never under any circumstances be employed at the present day, except during an open operation to diminish the size of the tumour and to aid exploration or removal of the cause. The same holds for injection with strong irritants such as iodine, and for massage.

Attempts have been made recently in women to dilate or cut ureteric strictures through a Kelly's tube by means of ureteric graduated bougies or internal ureterotomy knives. There is no need to fear infection if due aseptic and antiseptic precautions are taken. Some have even suggested repeated ureteric dilatation with bougies in cases where the ureter has been cut or diseased and shows a tendency to produce a stricture.

An operation for hydronephrosis may have to include exploration of the opposite kidney, if it is found impossible in other ways to prove its presence and functional value. This is followed on the affected side by *complete exposure of the ureter and pelvis from behind* as well as of the kidney itself, as only by this means can the true cause of the hydronephrosis be determined before the kidney itself is opened, and suitable

treatment planned. The site of the obstruction may have been determined by preliminary passage of a ureteric catheter, which may be left *in situ.*

If the obstruction is in the bony pelvis and cannot be remedied *via* the bladder, the ureter is dilated through most of its length, so that it can be exposed without much difficulty in the bony pelvis by the lumbar inguinal retroperitoneal route. Stricture or stone may be encountered, but too often a defect is found which it is impossible to remedy, and the kidney will have to be sacrificed; nor is it worth while wasting time over a difficult plastic operation in the pelvis if the kidney itself is almost obsolete.

If, on the other hand, the cause is at or near the uretero-pelvic junction (as it will be in at least half the cases), a plastic operation on ureter and pelvis can often be carried out with success, such as Fenger's operation of ureteroplasty or an operation of anastomosis between ureter and pelvis resembling Finney's operation of gastro-duodenostomy.

When an aberrant renal artery is found "bowstringing" the ureter, the simplest course is to ligature the artery in two places and cut it across. This has the disadvantage of cutting off the blood supply of the lower pole of the kidney, and leads to destruction of an appreciable quantity of valuable kidney substance, and does not always relieve the obstruction. For these reasons an effort might be made to get round the artery without cutting it, by means of uretero-pelvic anastomosis performed as for lateral anastomosis of two segments of gut.

When a twist or kink is found it is best to cut the ureter across below the kink and stitch it into a hole made in the lowest part of the dilated pelvis.

Sometimes—but this is not so often as was once thought—it appears that the kidney is unduly mobile and that this is the cause of the kink rather than the result. Anchoring the kidney in a higher situation may then suffice to relieve this condition, though the results of such operations are not always encouraging.

Nephrostomy with secondary nephrectomy is seldom required at the present day, as the functional power of each kidney can usually be determined before the operation.

Until more of these operations have been watched to their ultimate results it is impossible to know how much regeneration of the kidney substance can occur, so that it is not right to sacrifice the kidney straight away because it appears to

be in a condition of atrophy. Whenever possible a plastic operation should be attempted, accurate record of the kidney condition kept, and periodic and systematic ureteric catheterisation should be carried out for some years afterwards under strict aseptic precautions with the object, first, of *resisting the tendency to stricture,* and secondarily, to enable estimations of renal function to be made.

CHAPTER VII.

INFLAMMATION OF THE PELVIS AND KIDNEY. PYELITIS; PYELO-NEPHRITIS; PYONEPHROSIS; SOLITARY ABSCESS; PERINEPHRITIS; RENAL FISTULA.

INFLAMMATION of the kidney and pelvis is caused by the action of irritants, living or non-living, which can reach these parts by way of the blood-vessels, or locally in the urine or the lymph-stream. Either a non-living or a living irritant can act alone and set up inflammation, but in most cases a mechanical or chemical irritant acts first as a predisposing cause injuring the kidney, so that it then falls a prey to micro-organisms, which else had been powerless to attack it. Surgery, therefore, must not only concern itself with inflammation caused by bacteria, but must also take stock of the mechanical and chemical agents which predispose a kidney to bacterial infection.

Mechanical and chemical irritants can act on the kidney in two ways:

(1) As *exciting causes* of simple exudative inflammation, followed by resolution, or leading to degeneration of the kidney; (2) as *predisposing causes*, rendering the kidney liable to attacks by bacteria.

Bacteria, on the other hand, seldom attack a healthy kidney, but in the majority of cases can only attack a kidney already damaged by other irritants.

Causes of Inflammation of the Kidney and its Pelvis.

EXCITING CAUSES.

A. *Mechanical.*

1. Blows on the loin.
2. Calculus.
3. Movable kidney (pressure on vessels or ureter).
4. Back pressure—*Ureteric*, unilateral; *Urethral*, bilateral; (see p. 112).

B. *Thermal.*

1. Burns (toxic products of cell-destruction absorbed into the blood).

2. Cold (reflex flushing of kidney, the skin being deprived of blood).

C. *Chemical.*

1. Inorganic poisons, *e. g.* lead, mercury.
2. Vegetable poisons: The balsams, *e. g.* sandal oil, turpentine, mustard.
3. Organic poisons, *e. g.* alcohol, cantharides.
   Toxins of infectious fevers, *e. g.* scarlet fever.
   Auto-intoxication, gout, arterio-sclerosis, pregnancy.

D. *Living organisms* (pure or mixed infections).

1. Bacteria.
   - Common:
     - Tubercle bacillus (see Ch. VIII).
     - Bacillus coli and its varieties (85 per cent.).
     - Streptococci.
     - Staphylococci.
     - Proteus Hauseri.
   - Rare:
     - B. typhosus.
     - Anaërobes (Albarran).
     - B. pyocyaneus, lactic acid bacillus.
     - Pneumococcus, B. influenzæ, gonococcus, etc.
     - Anthrax, glanders.
2. Fungi. Actinomycosis.
3. Protozoa. Syphilis (Spirochæta pallida).
   Malaria.
4. Gross parasites, *e. g.* hydatid cysts, Bilharzia hæmatobia.

Predisposing Causes.

1. *Local.*
   A. *Trauma.* Bruising, calculus, movable kidney, back-pressure.
   B. *Previous attacks of inflammation.*
   C. *Vaso-motor disturbance.* Reflex nervous flushings.
      Menstruation.
      Instrumentation of urethra and bladder.
      Cold, alcohol.
2. *General.*
   A. *Poisons in blood, e. g.* lead, balsams, alcohol, bacterial toxins, auto-intoxication, diabetes, gout, pregnancy, malignant disease.

Bacterial Infections.

Mode of Attack.

Bacteria may reach the kidney by three routes:

1. *The blood-vessels* ("hæmatogenous," "descending" infection).
2. *The lower urinary tract* ("ascending" infection).
   - A. In the urine.
   - B. In the lymphatics of the ureter.
3. *The local tissue or lymphatic spaces*—
   - A. Through open wounds.
   - B. Through inflammation of neighbouring organs, *e. g.* peritoneum, pleura, retro-peritoneal tissues, liver, colon, etc.

I. Hæmatogenous Infection.

A. *This is the Common Mode of Infection.*

In the large majority of cases of pyelo-nephritis bacteria reach the kidney by the blood-stream. The idea that infection is commonly ascending is due to faulty methods of diagnosis in cases seen late in their course. The early symptoms of pyelo-nephritis—bladder tenesmus and increased frequency of micturition—appear to accuse the bladder, and the cases are labelled "cystitis," are treated with lavage, and do not clear up. "Drink-cures" in some cases prove effective, but more often the condition becomes chronic, and eventually declares itself as one of pyelo-nephritis, the faulty inference being drawn that the kidneys have become infected secondarily to infection of the bladder.

Recent observations by means of the ureteric catheter, supplemented by operation and post-mortem findings, point more and more to the conclusions that:

(1) *Most cases of pyelo-nephritis are hæmatogenous in origin.*

(2) *In the early stages they are unilateral.*

In fact, just the same conclusions as have been reached with regard to tuberculous infections (see Ch. VIII) are found to hold good for infection with other organisms.

B. *Sources of the Bacteria.*

What are the paths by which the bacteria reach the blood-stream?

Occasionally some obvious source of infection can be

observed, for instance, a furuncle, an inflamed tonsil, a typhoid ulcer, or the patient may already be the victim of pyæmia or septicæmia, but in most cases no such source can be found.

The observations of numerous observers (Nocard, Behring, Adami, Nicholls, etc.) go far to establish as a fact that organisms are constantly entering the blood through the healthy throat and alimentary canal by way of the lymph stream, especially during periods of fatigue or fasting (Ficker), or if the onward passage of fæcal matter be stayed as by constipation, or ligature of the bowel (Posner and Lewin, 'Berlin. med. Gesell.,' February 6th, 1895, etc.). Such organisms as the *Bacillus coli, Proteus Hauseri,* the *tubercle bacillus* are constantly being carried by the blood-stream into the various tissues without causing any demonstrable local lesions at the site of entry.

c. *Fate of Bacteria in the Tissues.*

The bacteria, if they successfully evade the first line of defence, *the lymph nodes,* are constantly being picked out of the blood and destroyed by the endothelial cells lining the capillary blood-vessels of the liver, spleen, and kidney (Adami). It is also probable that the bacteria in a damaged state are excreted not only in the bile but also in the urine without doing any harm to the tissues of the liver or kidney, though evidence is somewhat conflicting in this connection.

The *experimental work* of Métin, Asch and others points to the conclusion that organisms are not excreted in the urine without damaging the kidney substance if the kidneys be examined *histologically,* whereas *clinical observation* suggests that organisms are often excreted in the urine without harm to the kidney *that is appreciable clinically.* For instance, the bacilluria in the third week of typhoid fever is well known, and Dudgeon has published the following results of bacteriological investigations of a series of urines :

Urine examined.	Result.
20 "normal individuals."	No organisms found.
20 "constipated individuals."	*Bacillus coli* present in 3 without symptoms.
20 cases of peritonitis.	*Bacillus coli* present in 4 without symptoms. In many a *staphylococcus* found. In 1 the *Proteus Hauseri.*

Urine examined.	Result.
45 pregnant women.	*Bacillus coli* present in 9 (in 8 no symptoms). In many a *staphylococcus* and the *Proteus Hauseri*.

One of the pregnant women without symptoms, in whose urine a *Bacillus coli* was found, afterwards developed an attack of pyelonephritis. *For practical purposes* then it may be accepted that the kidneys can excrete pathogenic organisms without any damage to their substance that is appreciable *clinically*, even though experimental work suggests that when organisms are found in the urine, some slight damage has been done to the kidney during their passage in the nature of a mild inflammatory reaction that could only be demonstrated by the microscope.

D. *Causes that determine Infection of the Kidneys.*

The mere presence of bacteria in or passage through the kidney does not therefore give rise to pyelo-nephritis, but some other factor is required acting in conjunction. The virulence or number of the bacteria probably plays a *minor rôle*, but the *most important factor is some previous damage of the kidney substance by a mechanical or chemical agent*. Various experimenters have injected pathogenic organisms into the peritoneum or into the veins of animals. In healthy control animals no inflammation arose in the kidney, but if the kidneys were previously damaged by a blow on the loin or by ligature of the ureter, inflammation almost constantly arose in the form of diffuse exudation with multiple cortical abscesses.

Clinically, bacteria seldom cause pyelonephritis except in conjunction with some predisposing cause such as back-pressure, calculus, or blows on the loin which damage the vitality of the kidney tissue.

Nevertheless suppuration is sometimes set up suddenly in *apparently normal* kidneys by the *Bacillus coli* entering from the blood. It is possible that in these cases the bacteria are in a state of exalted virulence, or attack the kidney in excessive numbers; but it is more probable that comparatively limited clinical methods of examination cannot detect the predisposing cause which has damaged the kidney, and were a close enough examination possible such a cause would probably be found in every case. The majority of these cases occur in women, and the right kidney is selected for attack,

just the very cases in which slight degrees of undue mobility of the organ are met with sufficient to account for the predisposing damage of the tissues.

II. Ascending Infection.

This is much less common than was once held and taught, and the following axioms can now be laid down based upon clinical and experimental work.

1. Organisms do not ascend against the urine stream in health.
2. Organisms only ascend the ureters from the bladder under two conditions of disease :
   (*a*) If there is an obstruction to the outflow of the urine from the bladder *with residual urine.*
   (*b*) If the valvular muscular mouth of the ureter is rendered incompetent either by ulceration or by degeneration of its muscular wall.

The kidney is therefore protected by two mechanisms from ascending invasion :

1. The downward current of urine.
2. The physical condition of the healthy ureteric orifice.

This emphasises the importance of maintaining a good diuresis when ascending infection is feared.

It is probable that even when cystitis is primary, the kidneys, if infected secondarily, do not necessarily become so by ascending infection, as organisms can enter the blood from the infected bladder, and cause a hæmatogenous infection of one or both kidneys. It is said that there is anastomosis along the ureter between the lymphatics of the bladder and the kidney (Stevens, Sokota, Sampson), and certain authors state that ascending infection can occur in this way.

Ascending infection is not nearly so common as it was once thought to be, and rarely occurs apart from gross obstruction to the flow of urine. A simple cystitis hardly ever leads to ascending infection.

III. Local Spread by the connective tissue and lymphatic spaces.

Local spread is not common, but does sometimes occur. For instance, in a case of pneumonococcic empyema on the left side, which was drained and had healed, death occurred, and an autopsy was performed, which revealed a left perinephric abscess with miliary abscesses in the cortex of the

upper pole of the left kidney, and we have seen a post-colonic abscess taking origin in the cæcum giving rise to a similar condition.

Reflex Nervous Disturbance.

The important part which the nervous system plays in renal inflammations merits attention.

The experiments of Tuffier and others show that interference with the deep urethra (*e. g.* instrumentation) causes a reflex engorgement of the kidneys with exudation and ecchymosis, and clinical experience affirms that in highly strung persons the mere passage of a clean instrument through a clean urethra may give rise within a few hours to all the symptoms of inflammation of the kidney, which may shortly subside, may recur, may lead to suppuration, or to rapid death, the autopsy revealing nothing but engorged or œdematous kidneys. It would appear that mechanical interference with the lower urinary tract in certain susceptible individuals may cause reflex engorgement of the kidneys, and that this in itself is sufficient to predispose the kidneys to attack by any organisms that may be circulating in the blood at the time. Hence the importance before passing a urethral instrument not only of rendering sterile the urethral instruments and the urethra itself, but also—

1. of de-sensitising the urethra by means of cocaine—"nerve-blocking";
2. of avoiding other agents which cause reflex renal flushing such as cold, menstruation;
3. of clearing out any source of possible blood infection previous to the operation, that is to say, the bowel, the mouth, throat, and skin, and of producing good diuresis and diaphoresis.

Age.—Renal infections may occur at any age, and are not at all uncommon in children, and account for many "obscure" cases of "incontinence," "cystitis," and "stone," but can only be properly recognised by collection of the urine by sterile methods for bacteriological examination, a difficult task in children, yet one that can be surmounted.

Sex.—Characteristic of women are attacks of pyelo-nephritis in one kidney, usually the right, the predisposing cause being the gravid uterus, a pelvic tumour or a movable kidney.

Characteristic of men are attacks in both kidneys, the predisposing cause being stricture of the urethra or enlarged

prostate, but even in these cases one kidney is sometimes attacked before the other.

Pathology.

Morbid Anatomy and Histology.

A. *Descending Hæmatogenous Inflammations.*

An irritant may descend upon a healthy kidney, a kidney showing early back-pressure changes, that is to say, slight dilatation and atrophy of the tubules combined with slight interstitial fibrosis, or upon a kidney showing advanced back-pressure changes, nephrectasis (see Ch. VI). It is sufficient to describe the changes seen in an attack on a comparatively healthy kidney, and is unnecessary to describe the changes wrought by mechanical or chemical irritants, as they closely resemble the early changes wrought by micro-organisms, from which they differ in the fact that they are powerless in themselves to produce suppuration.

Organisms are deposited in the walls of the blood-vessels of the kidney, either diffusely throughout the whole or part of the kidney, or as emboli in the capillaries of the Malpighian tufts, or as infarcts in the larger vessels, from which they make their way into the interstitial connective-tissue spaces and into the lumen of the tubules and pelvis. The blood-vessels dilate and pour out an exudation of plasma and leucocytes and even red blood-corpuscles into the connective tissue spaces and lumina of the tubules. The local cells—the connective-tissue and secreting cells—if not killed at once by the virulence of the poison, multiply and form phagocytes and antibodies, in order first to neutralise and remove the poison, secondly to repair the damage done. One of two things may happen.

1. *The tissues prevail.*—The organisms are destroyed, the *débris* is carried away, and the cells reproduce fresh tubule and connective-tissue cells. In this way the kidney may be restored to its former state, or less favourably a scar be left in which the tubules are degenerated and the interstitial fibrous tissue is in excess (scar, fibrosis, interstitial change), a weak spot always liable to fresh attacks of inflammation.

2. *The bacteria prevail.*—(*a*) The tissue cells are destroyed and digested by the leucocytes so that abscesses are formed, either minute miliary abscesses or large confluent abscesses; and rarely total gangrene of the kidney may ensue.

(*b*) The bacteria or their poisons enter the blood and cause sapræmia, septicæmia, or pyæmia.

With the naked eye the following conditions are seen:

1. *In the early stages* the kidney appears large, tense, engorged, and on section the surface bulges up and drips serum and blood. Infarcts may be seen, and the pelvis is inflamed and covered with exudate.

2. *In the later stages* miliary abscesses may appear in the cortex, or large confluent masses of pus, or long linear streaks of pus in the tubules or in the interstitial tissue between the tubules. Rarely the whole kidney presents as a gangrenous mass.

3. *Later still*, if more or less healing has occurred, the capsule is seen to be adherent, scars are seen in the site of old emboli, interstitial fibrosis appears in patches or throughout the whole kidney, the cortex shows atrophy or fatty degeneration, but in places there may be patches where true compensatory hypertrophy has occurred.

A not uncommon result is the formation of multiple abscesses with an inner wall formed by a thick layer of granulation tissue surrounded by an outer wall of fibrous tissue, which burst from time to time into the tubules and keep up a constant or recurring irritation of the tubules and pelvis, and a condition of intermittent pyuria. This condition may last for years without either clearing up or destroying the patient. Large branched phosphatic calculi form in some cases in the cavities of the abscesses, or in the inflamed and dilated pelvis and calices (secondary calculi), a result which seems to depend on the presence of the *Proteus Hauseri*, which alkalinises the urine.

Summary of Pathological Changes found as a Result of Bacterial Infection.

1. Interstitial Tissue.

A. *Exudation.* *Resolution, restitutio ad integrum.*
Fibrosis—local scars
—general scar, "chronic interstitial nephritis."

B. *Suppuration* in the form of
- diffuse infiltration.
- miliary abscesses.
- infarct and gross abscess.

Results :

x. *Absorption,* and scars.

y. *Formation of chronic thick wall abscesses* lined by granulation tissue.

z. *Spreading suppuration.*

1. *Local spread*—to tubules, pelvis, and lower urinary tract.
   —to perinephric tissues.
   —to peritoneum and its contained viscus.
   —to pleura and lungs.
   —to skin (= renal fistula).

2. *General spread*—into lymph-channels, lymphangitis, lymphadenitis.
   —into blood—sapræmia.
   —septicæmia.
   —pyæmia.

c. *Gangrene.*

2. Parenchyma Cells of Tubules.

A. *Proliferation* = "catarrh."

B. *Cloudy swelling*—resolution—hypertrophy—atrophy.

C. *Fatty degeneration.*

D. *Necrosis.*

3. Pelvis.

A. *Hyperæmia,* catarrh, muco-pus.

B. *Ulceration* with formation of granulation tissue secreting pus.

C. *Formation of membrane.*

4. Contents of Tubules and Pelvis.

Products of catarrh
- —pus.
- —casts.
- —necrotic *débris.*
- —secondary calculi.

Secondary Effects.

Pyonephrosis (see p. 156).
Secondary calculi (see p. 70).
Circumscribed abscess (see p. 162).
Perinephritic abscess (see p. 163).
Renal fistula (see p. 170).

B. *Ascending Infections.*

Organisms reach the pelvis of the kidney in the urine, or in the lymphatics of the ureter, whence they spread up the tubules themselves, and are absorbed into the connective-tissue spaces and lymphatics of the kidney. They may attack the lower pole at first or quickly spread throughout the whole of the kidney.

The kidney nearly always shows evidence of back-pressure, that is to say, dilatation of the pelvis and tubules, with fibrosis of the interstitial connective tissue (see p. 115), and when removed at the post-mortem is engorged with blood and serum, the capsule is adherent, and the cut surface bulges up and serum drips from it. The cortex is a dirty yellowish brown, is thinned out, and exhibits streaks of pus, with here and there minute abscesses. The pyramids are obscured by the œdema and show similar streaks, or they may stand out as red triangular areas. The pelvis is dilated, its surface inflamed, and covered with pus, and may present ulcers or patches of membrane. The apices of the pyramids may be ulcerated or covered with membrane, and it is only a question of degree between such a condition and that of advanced pyonephrosis (see p. 156).

Bacteriology.

In the large majority of cases of pyelonephritis, bacteriological investigation of the urine shows that some variety of the colon bacillus is the organism present, the tubercle bacillus being excluded from the present considerations. In a large series of cases a bacillus of the *coli* group is found in something like 85 per cent. (Lenhartz). The organism is not specific, but a number of sub-groups closely related to one another can be distinguished by cultural methods, so that in each individual case it is necessary to isolate the individual strain of *Bacillus coli* present if bacteriological methods of treatment are to be employed. The strain may alter its character from time to time in the same patient, probably as an adaption to altered environment caused by altered products of defence on the part of the body, a fact which has a bearing on bacteriological treatment. In many cases of "typhoid" bacilluria, the organism present is the *colon bacillus* and not the *B. typhosus*. The only other organisms at all commonly found are *staphylococci* (*albus* and *aureus*), *streptococci*, and the *Proteus Hauseri*.

The finding of other organisms has been reported in stray cases in the literature, but their occurrence *is very rare,* such as the *pneumococcus, gonococcus, B. influenzæ,* etc.

In the later stages, especially when abscesses are present, numerous varieties of secondary infecting organisms are found, many of which are probably saprophytic in the pus itself. Albarran and Jungano have found anaërobes by using special cultural methods, but it is doubtful if these play more than a *minor secondary rôle.*

Clinical Course.

Bacilluria or Bacteriuria causes no symptoms, the only sign being the passage of bacteria in the urine. If in sufficient numbers they become evident to the naked eye as a diffuse shimmering haze in the urine, which does not disappear on the addition of acids or alkalies, is unaffected by heat, and cannot be removed by ordinary filtration. Sometimes, but by no means invariably, the urine has a fish-like odour or even smells fæculent, but it is important to note that *urine swarming with the Bacillus coli may not present any characteristic smell.* In lesser numbers bacteria can only be detected in the urine by means of *cultural methods applied to catheter specimens obtained with full aseptic precautions.* Urine that looks clear and normal may contain myriads of bacteria, but the bacteria may clump if the urine is left standing for a few hours, and fall to the bottom of the glass as a white flocculent deposit. The bacteria usually found are the *Staphylococcus albus* and the *Bacillus coli.* The urine may be acid or alkaline and be turbid with phosphates. The bacteria appear to have their nest either in the kidney or the prostate, to which attention must be directed in diagnosis and treatment.

Renal Infection.

When true inflammation of one or both kidneys arises certain characteristic signs and symptoms are usually present, which vary in degree with the virulence of the infection, being a combination of those of "sapræmia" with those of "uræmia." Even when only one kidney is affected anatomically both kidneys appear to be affected physiologically.

General Symptoms.

The onset is sudden and is ushered in by a rigor, which ranges from a slight shiver to a severe ague lasting twenty

minutes or more. Vomiting is almost a constant feature, and with it go loss of appetite and distressing thirst, and profuse diarrhœa alternating with constipation is common. The skin is dry at first, but when the rigor is over it breaks out into a drenching sweat. Frontal headache of a dull aching character is usually complained of, and in severe cases there is delirium, which may end in fits or even coma.

Local Symptoms.

Pain is present even in the mildest cases, and varies from a dull ache in the back of one or both loins, to a severe pain spreading from the middle of the back at the level of the twelfth dorsal vertebra along the loin below the twelfth rib to the pit of the epigastrium just above the umbilicus. Sometimes this pain spreads down along the course of the ureter into one or both groins, but more often it suggests a severe peritoneal crisis in the upper abdomen such as that of a perforated gastric ulcer, acute cholecystitis or acute appendicitis. *Cramping pains in the neck of the bladder* and at the end of the penis are common and may be so severe as to mask the renal pain; as in tuberculosis of the kidney, they often mislead the practitioner into a diagnosis of "cystitis." They are produced either by a ureteric reflex or by the irritating effect of the altered urine on the wall of the bladder and deep urethra. *Frequency of micturition* is much increased *equally by night* as by day, which, combined with the bladder pain, is very misleading, unless the rule be remembered that *bladder pain and increased frequency of micturition are as often symptoms of diseased kidney as of diseased bladder.* The patient may complain that the urine is turbid or contains blood, but much more often can tell nothing that leads to a suspicion that the urine is at fault in the absence of routine examination.

General Signs.

The temperature shows an initial sharp rise even to as high as 106–107° F., especially if there is a definite rigor, and comes down gradually during the next few days till it becomes subnormal, where it remains till the attack has quite passed off, and then rises again to the normal. In severe infections with the *Bacillus coli* the temperature may remain at 103–105° F. for many days and then gradually return to normal, or else it may oscillate daily from subnormal to 104–105° F.,

the periods of rise being marked each time by a definite rigor. In relapsing cases the temperature remains normal for some days or weeks, then rises again for a period of days. *Many cases of obscure recurrent pyrexia can be explained if the urine be carefully examined.*

The tongue is dry, covered with white or brown fur, and the throat is parched. The pulse-rate is increased and in acute attacks may rise to 130–140 to the minute. The blood-pressure is not markedly raised in a single acute attack, but in chronic cases with acute exacerbations it may be found raised to 170–200 mm. of mercury, so that blood-pressure readings often help to distinguish in a most valuable manner acute attacks on healthy kidneys from acute attacks on old fibrotic kidneys. With the raised blood-pressure go thickened arteries and hypertrophy of the left ventricle of the heart.

Muscular twitchings of the fingers, general convulsions, and delirium passing into coma may be observed in severe cases.

Œdema is seldom seen except in chronic cases with a very acute exacerbation, nor is anæmia an early feature. Wasting of fat and muscle comes on rapidly if the attack does not pass away in a few days.

A polymorphonuclear leucocytosis is present in acute attacks, and tends to persist if suppuration has occurred, so that frequent blood examinations may prove of use in deciding whether to explore in doubtful unilateral cases.

Local Signs.

Deep tenderness is practically always present in the "renal angle" in the back of the loin, even in the slightest cases.[1] In acute cases it is very marked, and is combined with deep tenderness over the front of the abdomen in the hypogastric regions and along the course of the lumbar ureter and with rigidity of the belly wall.

The kidney is in many cases not to be felt, sometimes because it is not very much enlarged, or is adherent and tucked away under the ribs, at other times because the patient is obese, or is pregnant, or because the belly wall is tender and rigid. In less acute cases, and in thin women, the kidney may often be felt freely movable, and may feel enlarged and be tender when caught by the fingers. In cases of pyone-

[1] The "renal angle" lies between the twelfth rib and the edge of the erector spinæ.

phrosis there is a very large "renal tumour," which is not necessarily very tender and often moves downwards one to two inches during inspiration. Such a kidney bulges inwards and forwards against the anterior belly wall during inspiration—a point that serves to distinguish it from a perinephric abscess, which is fixed and bulges back into the back of the loin. Redness and œdema of the belly walls do not occur apart from perinephric abscess.

In females there is seldom any further evidence to be gained in the lower urinary tract, save that the ureters may be felt *per vaginam* thickened and tender, but *a routine pelvic examination is compulsory with a view to detecting any predisposing cause* such as a pregnant uterus or other pelvic tumour, and the presence of a ureteric stone.

In males, soon after the onset, signs of irritation or infection of the lower urinary tract are common, and a slight urethritis is sometimes seen for a few days, and must be sharply distinguished from a primary venereal urethritis. Prostatitis is common, being sometimes held to be the starting-point of the disease, and an acute epididymo-orchitis may arise on one or both sides with suppuration as an occasional sequela, the pus yielding a pure culture of the *Bacillus coli* or other infecting organism.

The urine should be examined by physical, chemical, and adequate bacteriological methods, failure to carry out a complete bacteriological examination of a catheter specimen of the urine being the cause of many failures.

States of Urine Found.

1. Clear. Culture and the microscope show bacteria in large numbers.
2. Hazy. The haze does not clear on addition of acetic acid, on heating, or on filtering, and settles down into a flocculent mass on standing—"bacteriuria" or "bacilluria," no pus cells being present.
3. Hazy. Bacteria and pus cells present.
4. Pyuria. The pus settles down into a thick layer at the bottom of the glass and leaves a haze above.
5. Profuse Hæmaturia. "Port wine" masking pus and bacteria; not at all uncommon at the onset in acute *Bacillus coli* infections.

The urine is usually acid but may be neutral or even alkaline, especially in chronic cases, the reaction depending on whether

the organism present is capable of splitting urea into ammonium carbonate and ammonia. The *Bacillus coli* and *streptococci* do not split urea, but *staphylococci* sometimes and the *proteus* always do so.

Albumen is usually present, but may be absent, and it varies in amount, being present in large amounts in acute cases (one sixth to one fourth or even more).

Casts may be present, but are often absent, being easily destroyed by decomposition of the urine or the centrifuge.

Polyuria is present in chronic cases, but in acute attacks there may be oliguria which may pass into complete suppression of urine. This may subside, or may persist and cause death in four to ten days.

During acute or subacute attacks the total amount of urinary solids is diminished, the urea and salts being notably lessened—that is to say, the functional power of both kidneys is depressed; but during quiescent periods in chronic cases, though the percentage of solids and specific gravity is consistently diminished, yet the total quantity of solids passed is up to the average of health if the amount of urine in the twenty-four hours be observed, since this quantity is persistently increased in amount. Specific opsonins are not to be found in the urine (Dudgeon) either because they never reach the urine from the blood, or because the urine has been deopsonised by the bacteria, but specific opsonins, agglutinins, etc., may be present in the blood, especially in chronic cases.

The cystoscope yields valuable evidence in suitable cases, but its use had best be avoided during acute attacks, especially acute attacks on a chronic condition (as shown by the past history, the blood-pressure, etc.), the only exception being in the rare hyperacute unilateral cases where the question of immediate nephrectomy arises (see "Treatment"). Opportunity for cystoscopy will arise later if it becomes necessary after rest in bed and other measures have allayed the more serious signs and symptoms.

The chief indications for cystoscopy are:

1. At the close of an acute attack, if the pyuria and bacilluria persist—
    - (*a*) To confirm the diagnosis and distinguish the disease from simple cystitis.
    - (*b*) To determine whether the disease is unilateral or bilateral.
    - (*c*) To determine the functional value of each kidney.

(*d*) To wash out the pelvis and ureter.
(*e*) To aid in the diagnosis of complicating ureteric obstruction, especially stricture and calculus.

2. In hyperacute cases suspected of being unilateral, where death is threatening and nephrectomy is being considered.

Cystoscopic Appearances.

The whole bladder wall may appear inflamed, but more frequently the inflammation is confined to the mucous membrane surrounding the mouth of that ureter from which the kidney infection is descending. The lips of the orifice are red, swollen, and pouting; the mucous membrane around shows a bullous œdema or is intensely engorged and covered with membrane. Ulcers are not common apart from tuberculosis. Pus and even blood may be seen issuing from the ureteric mouth. At the same time, even in unilateral affections the inflammation may spread in the bladder wall till it appears to surround the mouth of the healthy ureter.

In the less acute cases it is justifiable to catheterise the ureters and examine the urine from each with the object of determining if one or both kidneys is infected and the functional value of each. The non-affected kidney is often depressed in function reflexly or in "sympathy" with the other kidney, or in consequence of the accompanying toxæmia, for which reason some authorities prefer not to take the risks attendant on catheterisation of the ureters, and when there is no question of nephrectomy this is undoubtedly the only course to be pursued. When, however, the question of nephrectomy arises, as it does in certain cases, acute and chronic (see p. 155), the risks of catheterisation are not so great as the risks of nephrectomy without catheterisation. *Radiographic examination should never be omitted* as the infection is often secondary to a calculus in kidney or ureter, and in chronic cases large, branched, phosphatic calculi tend to form in the pelvis and calices on one or both sides.

Clinical Varieties.

A. Bacteriuria or Bacilluria.
B. Simple Inflammation.
—Single attack.
—Recurrent attacks.

C. SUPPURATION.
—Acute.
—Chronic.

D. FULMINATING ATTACKS.

1. *Without renal tumour.*
2. *With renal tumour.*
—Simple inflammatory swelling.
—Pyonephrosis.
—Perinephritic abscess.
—Single abscess.
—Hypertrophy.
3. *With renal calculi.*
—Primary.
—Secondary.

In males pyelonephritis is generally secondary to a stricture (age thirty to fifty), or to an enlarged prostate (age fifty to seventy).

In females the disease may be secondary to pressure on the ureter by the pregnant uterus or other pelvic tumour; but not infrequently it appears as a primary acute attack on the right side, the kidney being healthy apart from slight excess of mobility.

The symptoms and signs of any clinical variety are similar in kind but differ in degree, being those of—

1. Sapræmia or septicæmia.
2. Uræmia.

A. BACILLURIA.

This has already been discussed (see p. 134).

B. SIMPLE INFLAMMATION—ACUTE AND CHRONIC—SINGLE OR RECURRENT ATTACKS.

1. *Acute Single Attack of Simple Inflammation on Healthy Kidneys.*

The attack is ushered in with a rigor and the temperature rises to 102–103° F., or even higher. The patient sweats profusely, feels drowsy, and complains of thirst, loss of appetite, nausea, and frontal headache. He may vomit once or twice, and either the bowels are confined or there is diarrhœa. The urine is diminished in amount, the total solids being decreased, and contains pus.

In twenty-four to forty-eight hours the attack passes away, the temperature drops to normal, and all the symptoms disappear, but the urine may continue to be purulent for a time. Complete recovery is the rule, but the kidney may be left in a damaged condition and more liable to fresh attacks of inflammation, simple and suppurative.

2. *Recurrent or Relapsing Attacks of Simple Inflammation.*

These resemble acute single attacks, but they tend to recur at intervals of days, weeks, or months, and each time leave the kidney in a more damaged and degenerated condition.

3. *Mild Attacks on Kidneys the Victim of Chronic Back-Pressure.*

Back-pressure in itself gives rise to no symptoms besides pain in the back of each loin, but its secondary effects, inflammation and fibrosis, are sooner or later made manifest by a characteristic combination of signs and symptoms. Slight anorexia and thirst, occasional nausea or even vomiting, attacks of diarrhœa, attacks of chilliness and shivering, followed by excessive sweats, drowsiness, lassitude, and languor, wasting and polyuria, should make the diagnosis certain if a cause of back-pressure is known to exist.

Routine examination of all the systems confirms these suspicions. The cardio-vascular system often shows characteristic changes; there is well-marked arterio-sclerosis, with persistent high blood-pressure—often to 160–200 mm. of mercury, combined with hypertrophy of the left ventricle of the heart, the optic discs revealing thickened vessels, hæmorrhages, and rarely retinitis and optic neuritis. The tongue may be moist and clean, though thirst is marked. The temperature chart may reveal nothing, or may show a subnormal temperature marked by periods of sudden rise to 101–102° F. combined with rigors, and with a gradual return to the normal after two or three days.

The daily amount of urine is increased in quantity, 70 to 80 oz. being passed in the day; the specific gravity is lowered, and also the percentage values of the urea and salts, but the total quantity of urea and salts excreted in the twenty-four hours is not below the average during the quiescent periods. During the periods of exacerbation of acute inflammation, the urine is diminished in quantity and the total amount of solids decreased, till after many such attacks the kidneys fail to do

their work properly, there is persistent oliguria, leading, perhaps, to complete anuria, the urine is full of pus, the temperature remains subnormal, headache, vomiting, and thirst increase, and the patient passes into coma and dies of uræmia.

c. Suppuration: Acute Attack.

The symptoms and signs resemble those of an acute simple attack, but are more severe, the temperature tending to remain high—103–105°F.—the rigors being more violent and being repeated at frequent intervals.

The urine contains a large amount of pus, except in the case of a pyonephrosis where the ureter is temporarily blocked. The kidney is very tender if it can be felt through the rigid muscles and is generally enlarged, especially if a large abscess, a pyonephrosis, or a perinephric abscess is present.

Suppuration of the kidney is often fatal in the early acute stages, being the chief cause of death in men with neglected strictures or enlarged prostates, and even if the acuteness of the attack abates a condition of chronic suppuration is left which proves very obstinate of cure.

Suppuration should be suspected whenever the signs of inflammation of the kidney are severe and tend to persist, especially if rigors are repeated from day to day, and the urine contains large amounts of pus. A persistent leucocytosis with relative increase in the polymorphonuclears is an additional sign of some value.

The diagnosis of suppuration may be suspected from the persistence of the pyuria, but can only be confirmed by the formation of definite abscesses in the kidney and perinephric tissue or by inspection of the kidney at operation or autopsy.

Chronic Suppuration.

The disease may pass into a chronic stage in which all the acute symptoms disappear, yet the patient continues to pass pus in the urine for months or even years, never really well, yet very little inconvenienced by the disorder save for occasional subacute relapses with rigors and vomiting.

For instance, a woman with "congenital cystic kidneys" attends the London Hospital in whom suppuration has existed in the kidneys for nine years, the right kidney having been explored nine years ago and being found to contain abscesses. Pus and the *Bacillus coli* have been present in the urine ever

since, and though the right kidney had to be removed lately, and was found to contain innumerable small abscesses with thick walls from the size of a pin's head to that of a pea, yet the general health has been hardly affected during all that time, and still remains good.

There seems reason to think that some of these suppurative cases eventually clear up, the pus being absorbed or discharged into the tubules and multiple scars left, but this is not a common termination. Most cases of persistent infection of the urinary tract by the *Bacillus coli* which fail to respond to all "medical" and "vaccine" treatment carried out for months and even years are instances of this condition. If the disease is bilateral nothing more can be done. *But in many cases the disease is unilateral, and this can be proved by ureteric catheterisation. In such cases nephrectomy will cure the patient.* This fact will be recognised more and more in the future and nephrectomy be carried out with successful results, just as has happened in dealing with tuberculosis of the kidney.

D. Fulminating Attack: With Miliary Cortical Abscesses or Infective Gangrene.

This is a condition which has only attracted attention in the last decade, but is not uncommon. Virulent bacteria suddenly fall upon the right kidney in a woman previously quite healthy. It is probable that the infection is predisposed to by slight undue mobility of the organ, which has caused congestion of the vessels or kinking of the ureter.

A woman in good health is suddenly smitten down with a severe abdominal crisis, ushered in by a sharp rigor, the temperature rising to 105–108° F., the pulse-rate being increased to 130–140 to the minute, the beat being thready and weak. She complains of intense pain in the middle of the back at the level of the twelfth dorsal vertebra, and of severe mid-epigastric pain. She vomits and is troubled with diarrhœa or obstinate constipation. She passes water every half hour, and has cramping pains along the ureter and in the neck of the bladder, and in very severe cases she may have noticed profuse hæmaturia, but often she complains of nothing which draws attention to the urinary tract, and is apt to be considered and treated as a case of severe peritonitis, but careful examination distinguishes the case from peritonitis by the following points: The abdomen is rigid and tender over the

right hypogastrium and loin, but not elsewhere, and there is agonising *tenderness* if *pressure be made in the right "renal angle."* If bladder symptoms are present the uro-genital tract is at once suspected.

The urine gives the clue to the case. It is scanty, acid, and contains a large amount of hazy pus and albumen, but this may be masked by profuse hæmaturia, and the microscope shows in addition to the red blood-corpuscles large quantities of pus cells. Bacteriological examination shows usually the *Bacillus coli* in pure culture, but at times other organisms, such as *streptococci, staphylococci* and so forth.

Operation or autopsy reveals an intense inflammatory engorgement of the kidney combined with miliary cortical abscesses or infarcts, and in rare cases the whole kidney becomes gangrenous. Certain surgeons hasten to operate in these cases, and removal of the affected kidney has certainly been attended with success. Some cases undoubtedly die in a few days if nothing is done, but it is astonishing with what rapidity all the acute symptoms may pass away, even in the acutest cases, if the patient is kept at rest in bed. In favourable cases the trouble may completely disappear in two to three weeks, or the condition may pass into one of chronic unilateral infection of the kidney, when it is time to perform cystoscopy and consider nephrectomy.

"The Pyelitis of Pregnancy."

This condition has attracted attention in recent years, but there is no reason to mark it off as a separate disease. As Dudgeon and others have shown, many pregnant women suffer from bacteriuria (*Bacillus coli, proteus, staphylococci*). If at the same time the pregnant uterus presses upon the right ureter, it produces back-pressure on the right kidney, which may then become infected with the particular organism present in the urine. The inflammation may be simple or suppurative; the attack may be mild, acute, or fulminating, and differs in no way from those already described.

The following reasons have been brought forward to explain why it is that the right ureter is the one to be compressed at the brim of the pelvis by the pregnant uterus:

1. In a normal pregnancy there is dextro-rotation of the uterus, the left broad ligament comes forwards, the right passes backwards (Matthews Duncan).

2. The long axis of the fœtal head is more often in the right oblique diameter of the pelvis.

3. The right common iliac artery is much nearer the brim of the pelvis than the left, so that the right ureter is more prominent as it crosses it (Matthews Duncan).

Pyonephrosis, circumscribed abscess, chronic suppuration associated with secondary calculi, and perinephric abscess are considered in separate chapters.

Diagnosis.

In diagnosis certain questions have to be answered.

1. *Is there back-pressure, and if so, what is the cause?* Is it *unilateral*, ureteric or *bilateral*, vesical or urethral?

If a source of back-pressure is found, the following symptoms are characteristic of mild degrees of inflammation: Pyrexia, rigors, sweats, thirst, anorexia, nausea, vomiting, flatulence, diarrhœa, dry tongue, wasting; if in addition there are cardio-vascular change and high blood-pressure and the urine is persistently increased in amount, is pale, poor in solids and perhaps shows a faint trace of albumen, and especially if it contains bacteria and pus, then there should be no hesitation whatever in making a diagnosis of simple inflammation with back-pressure. If attacks occur with increasing frequency and severity it is an indication that fibrosis and degeneration are proceeding apace: while persistent pyrexia and recurrent rigors, combined with leucocytosis and large amounts of pus in urine, which grows daily more scanty, suggest that suppuration has occurred.

2. *If there is no back-pressure, is there any other predisposing cause at work?*

There remain to be excluded such things as trauma, movable kidney, calculus, tuberculosis, and in the great majority of cases some such condition will be found, though undoubtedly a few cases will be met with where no predisposing cause can be detected and in which a healthy kidney has been attacked by bacteria.

3. *What variety of inflammation is present?* Is it acute or chronic, simple or suppurative?

The simple varieties are distinguished by their less severe course, and by the fact that they clear up quickly in a few days to weeks. The symptoms quickly subside, the leucocytosis disappears, and the urine becomes clear.

4. *What micro-organism is responsible?*

This can only be settled by complete bacteriological

examination of the urine drawn off under *aseptic* conditions with a sterile catheter, through a cleansed urethra into a sterile flask, which is submitted to microscopical and cultural examination and inoculation experiments.

The most common organisms found are those of the *Bacillus coli* group and the *Proteus Hauseri*, but almost any organism may be found, or a mixture of two or three, and it should never be forgotten that the tubercle bacillus may be missed unless several examinations are made for it in quiescent periods. For instance, a man was treated for pyelitis for six months, first for *Bacillus coli*, then for staphylococcic infection, till repeated examinations showed that the primary organism was the tubercle bacillus.

5. *Is the disease unilateral or bilateral?*

This can only be decided by—

1. *Cystoscopy.*
2. *Ureteric catheterisation* (precautions, see p. 185).
   This should only be employed—
   (*a*) In acute cases if the question of nephrectomy arises.
   (*b*) In chronic cases, in a quiet interval.
   For diagnosis.
   For estimation of renal function.
   For estimation of the amount of hollowing of the pelvis.
   For washing out the pelvis in chronic cases of pyelitis.

It should never be forgotten that a large, tender kidney may be the healthy hypertrophied organ, the diseased organ being a shrunken pyonephrosis no larger than a testicle. *Abdominal palpation is therefore a dangerous guide in attempting to estimate which kidney is diseased.*

Differential Diagnosis.

1. Cystitis.

It may be a most difficult problem to decide whether a patient is suffering from pyelitis, or cystitis, or both together, especially in acute cases.

Bladder tenesmus, increased frequency of micturition, and pyuria are common to both conditions.

Fever is seldom caused by a pure cystitis unless the urine is foul and intensely alkaline.

Fever with pus in acid urine is therefore in all probability due to pyelitis.

In the same way none but cases of acute alkaline cystitis cause such general symptoms as thirst, nausea, vomiting, flatulence, diarrhœa, and rigors and sweatings. If these are present it is practically certain that pyelo-nephritis exists, and especially if some cause of back-pressure is known to be at work. Severe pain in the back of the loin or in the epigastrium suggests that the kidneys are inflamed, especially if the kidneys are found enlarged or tender, or the belly wall over them rigid.

Attempts to differentiate the two by estimating the amount of albumen and looking for specific products of catarrh have been found untrustworthy. A large amount of albumen, one fifth or more, strongly suggests a nephritis; numerous casts would confirm the suggestion; but the cells of the pelvis cannot be distinguished microscopically from those of the bladder and deep urethra. In simple cystitis the amount of albumen is seldom more than one sixth. The character of the pus is no criterion.

If a case of "cystitis" does not clear up with lavage, pyelitis (or prostatitis) should be considered and excluded.

The only certain test is cystoscopy and ureteric catheterisation, which should seldom be carried out except in chronic cases. In acute cases the surgeon has often to remain content with a provisional diagnosis of pyelitis based on probabilities and a marshalling of a number of small signs and symptoms. It should be remembered that no disease is so often missed clinically, as post-mortem records amply reveal, so that the practitioner should not be satisfied with a diagnosis of cystitis until pyelitis has been excluded.

2. Bright's Disease, Acute and Chronic.

"Acute Bright's disease or toxic degenerative nephritis" a little resembles an acute bacterial infection of the kidneys, but the pain in the back is bilateral rather than unilateral. It is sometimes stated that the presence of œdema should serve to distinguish the two conditions, but in a real first attack of acute Bright's disease œdema is not always present. The only certain test is the urine. In acute Bright's disease the quantity of urine is much diminished, and the urine is nearly solid with albumen. If the urine contains casts in abundance, but no appreciable pus and no organisms, the diagnosis

is "acute toxic nephritis." If on the other hand it contains pus and micro-organisms the diagnosis is "acute microbic nephritis."

Patients with chronic degenerative nephritis ("large white," "small white kidney") suffer from exacerbations of the disease, during which the urine contains blood and casts, but œdema is then a constant feature.

3. Cases of Chronic Fibroid Degeneration of the Kidney; Granular Kidney.

These cases sometimes resemble cases of chronic aseptic nephritis due to back-pressure. Both are liable to microbic infection and to acute attacks of inflammation, during which uræmic symptoms supervene. Urethral stricture, enlarged prostate, and calculus should be excluded before making a diagnosis of "granular kidney."

The lumbar pain in the early stages is often labelled "lumbago," the pain and the chills "influenza." The intermittent attacks of pyrexia and rigors must be distinguished from those of typhoid fever, malaria, pyæmia, endocarditis, miliary tuberculosis, and pernicious anæmia.

Pyuria.

Pyuria must be distinguished from phosphaturia, excess of urates and bacilluria by the addition of acetic acid, by the potash test, and by the *microscope*.

What is the Source of the Pus?

(*a*) *Urethral pus* is excluded by means of urethral irrigation and the glass tests (p. 371).

(*b*) *Prostatic and vesicular pus* by rectal massage (p. 371).

(*c*) *Bladder pus* by the glass tests and the cystoscope.

(*d*) *Kidney pus* by the cystoscope and ureteric catheter.

Pus issuing from a ureter comes from the pelvis or kidney except on exceedingly rare occasions when an abscess has burst into the ureter from elsewhere. Renal pus is seen as a delicate milky fluid, which remains hazy after filtering, and does not completely settle down in the glass. The urine is generally acid, but in chronic pyelitis with phosphatic concretions or in the terminal stages it may become neutral or alkaline. The reaction depends to a large extent on the nature of the infecting bacteria (proteus, staphylococcus).

Pus in acid urine is not therefore by any means diagnostic of tuberculosis, as purulent urine is acid in the presence of other organisms, especially the *Bacillus coli* and the streptococci.

Prognosis.

In cases of acute simple inflammation the prognosis is good if the cause of back-pressure can be removed, and even though suppuration has occurred it may clear up after removal of the predisposing cause.

In acute fulminating infections of one kidney death may occur in the first three days, but the exact gravity is hard to estimate as no sufficiently accurate records of a large number of cases are yet in existence. The point is important, because some surgeons advocate early nephrotomy and nephrectomy on the ground that death is almost certain to occur without, but in our experience the majority of these cases will get over the acute attack if treated expectantly.

Nevertheless cases will be met with where the surgeon will feel that nephrectomy is necessary to save life. Seeing that some of the cases do die and that others recover completely and at once after immediate nephrectomy of a kidney full of multiple miliary abscesses, it is unwise to state that such treatment is not justifiable, and judgment must remain suspended till further evidence is forthcoming.

Many of the acute cases become chronic and persist for years without any very marked effect on the general health, though the formation of large secondary phosphatic stones is a complication that is likely to prove fatal in the absence of operation.

Death occurs from exacerbation of the infection or from gradual exhaustion by uræmia and septicæmia.

In the case of those patients who continue to pass bacilli and pus and all ordinary treatment fails, it is far better that an attempt should be made to accuse one kidney. If only one kidney is infected its removal will cure the condition completely and remove all risk of secondary infection, both of the other kidney and the lower urinary tract.

When there has been long-standing back-pressure on both kidneys the outlook is serious. Nevertheless removal of the obstruction may suffice to allay the tendency to the inflammatory attacks, even though the kidneys remain crippled and continue to pass urine containing bacteria, and in this condition the patient may live a comfortable life for years.

If, however, a well-marked attack of suppurative pyelonephritis supervenes on back-pressure kidneys, the illness is likely to be fatal in ten days to a fortnight.

Treatment.

Prevention is far more easy than cure. The surgeon should do all in his power to prevent infection of the kidney in the course of his manipulations and operations.

1. Preventive Measures.

(a) *General.*

Patients likely to develop renal inflammations are safest if they can afford to live in a warm, dry climate, free from cold winds. They should wear clothing that is warm and dry, and should avoid chill, damp, and excessive fatigue.

The diet should not throw excessive work upon the kidneys, so that excess of proteid and the purin bases should be avoided, and the diet should not contain kidney irritants such as spices, mustard, pepper, curry, ginger, radishes, and asparagus. Carbohydrates and fats can be freely partaken of, but the intake of common salt should be limited, as excessive quantities increase the excretory work of the kidneys. The white meats and fish are preferred to the red meats, and cellular organs such as liver, kidney, and sweetbread are forbidden.

Patients should be encouraged to drink plenty of bland fluid every day with the object of flushing out the kidney tubules. The best flushing effect is obtained by means of large draughts taken on an empty stomach (one to two pints). Such drinks as plain water, hot water, aërated water, lemonade, lime-juice, orange juice, barley-water, soda and milk, Vittel or Contréxeville water can be safely recommended. Excess of alcohol is particularly harmful, a drinking bout being very likely to bring on an attack of inflammation. If alcohol must be taken it should be in the form of the lighter wines such as claret or hock, taken only with a meal to aid digestion, thirst being provided for by the addition of a glass of plain water drunk separately. Tea and coffee may be allowed in moderation.

The healthy action of the skin should be encouraged by means of regular hot bathing and an occasional Turkish bath if the heart is sound.

The bowels must be carefully attended to so as to prevent stagnation and decomposition of fæces, which, as already stated, may give rise to infection of the blood with bacilli of the colon group and other harmful bacteria. A regular daily evacuation is the most efficient way to keep down the virulence of the intestinal flora, and if this cannot be obtained by means of a vegetable and fruit diet and a good habit, resort must be had for a time to laxatives. Attempts to attack the organisms *in situ* are of doubtful value, but can be made by means of such drugs as salol, calomel, izal, and the use of milk soured by the addition of a pure culture of the lactic acid bacillus, which is said to inhibit the growth of the *Bacillus coli.*

The hygiene of the mouth and throat should also receive attention, and any local infective process be cut short.

In the same connection, before any operation or manipulation on the urogenital tract, it is advisable to secure thorough purgation, diaphoresis and diuresis; nor should such proceedings be attempted on a woman while she is menstruating. During pregnancy the risks of pyelitis can be greatly diminished by similar means.

(*b*) *Local Measures.*

The risk of infection is a potent argument for early remedy of undue mobility of the kidney and renal calculus, and for the immediate relief of any source of back-pressure on one or both kidneys when once a diagnosis is made. In such patients, or in highly strung individuals, the first catheterisation or instrumental interference with the urethra should only be undertaken with great circumspection. Never sound lightly. The passage of a urethral instrument is an evil only to be resorted to if by that means a greater evil can be remedied. Never sound during acute attacks of inflammation, unless you consider life cannot be saved without. If possible the instrument should be passed in the patient's own bedroom, and he should remain in bed for twelve hours afterwards, a draught of warm water containing ten grains of urotropin and half an ounce of gin having been administered. If there is time, before the passage of an instrument clear the bowel, the skin, and the kidney. Avoid shock by using an adequate dose of cocaine, or novocaine (5 per cent. solution), but remember that large doses of cocaine, one to three grains, may prove rapidly fatal in old men, or when the urethra

is acutely inflamed. Novocaine is far less toxic, but at the same time rather less analgesic. Avoid sudden relief of tension in the case of a chronic distension of the bladder, as it leads to engorgement of the kidneys with blood. In such cases empty the bladder slowly by tying in a No. 5 E. catheter or by successive removals of small amounts of urine, sixteen ounces at a time. Avoid sepsis by lavage of the urethra and sterilisation of the hands and instruments.

If the urine already contains bacteria, and there is no urgency, efforts should be made to clear the urine by copious drinking, urinary antiseptics, urethral and vesical lavage, and it is better to wait a week or ten days before instrumentation. The blood tends to become more or less immune to the bacteria after this time, so that there is then less risk if the organisms or their poisons are introduced into the circulation.

2. Curative Measures.

A. *Medical.*

Two principles underlie all such measures:

(1) *To relieve congestion.*

(2) *To wash out the urinary channels.*

General.

Keep the patient at rest in a warm bed, avoiding chill, fatigue, and alimentary excess. Employ a milk diet so long as high fever continues, and *promote free diuresis by means of copious draughts of water and other bland fluids* (six to twelve pints a day). Interdict alcohol, with the exception of small doses of the diuretic gin to be used during the rigor in doses of half an ounce to an ounce.

Encourage sweating by means of warm blankets and hot-air baths, aided, if necessary, by small doses of pilocarpin nitrate injected subcutaneously (gr. $\frac{1}{6}$). Secure regular evacuation of the bowels by laxatives such as the pulv. jalapæ co. or Epsom salts, and an occasional purge such as croton oil.

Large, warm enemata of salt solution are of great value, but turpentine should not be used in enemata, because of its irritating action on the kidneys.

Dry or wet cupping of the loins relieves the pain in the back in remarkable fashion, and is far more efficient than the application of hot fomentations.

Drugs.

During acute attacks, especially when marked by rigors, quinine in doses of three to five grains three or four times a day will be found most valuable.

If pain is very severe, and does not yield to local applications, it may be controlled by the exhibition of morphia and atropin, though "aspirin" in ten-grain doses often proves helpful, and should first be given a trial.

In acute attacks it is well to start by producing "an alkaline tide" of urine by the use of potassium citrate in large doses (30 to 60 grains) every six hours, combined with tincture of hyoscyamus (♏ xx) and the infusion of buchu. In a few days "an acid tide" should be substituted by means of urotropin (gr. v) and acid sodium phosphate (gr. xxx) taken four times a day. If this mixture aggravates the "uræmic" nausea it must be discontinued, and a substitute provided in dilute nitro-hydrochloric acid (♏ x–xv). The balsams, such as turpentine, sandal oil, etc., should not be employed during the acute stages, as they increase the congestion of the kidneys, though they may prove of value in small doses in chronic cases.

The use of vaccines has so far proved disappointing after an extensive trial by numerous observers, but they are undoubtedly worth a trial if other measures fail, as they have proved successful in a few cases. It is necessary to make a vaccine from the patient's own micro-organism.

Dudgeon recommends the trial of his anti-*coli*-serum prepared by immunising horses to a number of different strains of the colon bacillus. It is only effective *in recent acute* infections, and is given in doses of 25 c.c. once a day for three days only, after which time it has no effect and should be discontinued. Intra-venous injection yields the best results. Dudgeon has used it in twelve acute cases, in most of them with highly satisfactory results.[1] If the serum is used, calcium lactate in twenty-grain doses should be given three times daily for at least ten days to prevent urticaria and joint-pains.

B. *Surgical Measures.*

In chronic cases with back-pressure on both kidneys the aim should be to remove the cause of the back-pressure.

[1] The serum can be obtained from Burroughs and Wellcome.

Strictures should be divided, and enlarged prostates removed or regular catheter life and lavage of the bladder instituted. In unilateral cases ureteric obstruction must be relieved (see Ch. VI). When this has been done the inflammation of the kidneys will usually subside and may clear up altogether, though the kidneys remain permanently crippled and an easy prey to fresh attacks.

In the right-sided pyelitis of pregnancy rest in bed in the supine position is usually found to be sufficient to relieve the obstruction. If this fails the patient should lie prone, or the foot of the bed should be raised on blocks so as to lift the uterus out of the pelvis. If these measures do not avail and the symptoms become urgent one of two courses must be adopted:

1. *The induction of premature labour,* after which the kidney mischief disappears rapidly, but the child is sacrificed.

2. *Nephrotomy with drainage* (*nephrotresis*) is performed, in which case the mother will probably go to term and the child will be saved, but the mother may be left with a renal fistula which it is difficult to get to close.

The former course is the better, unless there is some very urgent reason for saving the life of the fœtus.

Lavage of the pelvis by means of the ureteric catheter has been practised, solutions being used such as silver nitrate $\frac{1}{5000}$, oxycyanate of mercury $\frac{1}{4000}$, and so forth, applied two or three times a week.

As the inflammation is seldom confined to the pelvis, but also affects widely the cortex of the kidney, it is hard to see how it can be of much avail, and it is a tedious and painful procedure for the patient. Judgment must be suspended in this connection until further reports have been published.

The chief indications for the treatment are:

1. Mild degrees of pyelo-nephritis confined to one kidney which fail to clear up completely with medical measures.

2. Cases of persistent bacteriuria that are proved by the ureteric catheter to originate in the kidneys.

Operations.

Nephrotomy and Nephrotresis.

1. To drain a pyonephrosis, when the state of the other kidney is uncertain.

2. To remove renal calculi.

3. To anchor a movable kidney which is infected.

4. To expose the upper end of the ureter and remedy any obstruction found.

5. To open and drain any gross abscess either in or around the kidney.

6. To drain the kidney and save the life of the fœtus in cases of pyelitis of pregnancy.

7. To explore the kidney in fulminating unilateral infections, and establish drainage if nephrectomy is considered inadvisable.

Nephrectomy.

1. Secondary to nephrotomy, if there is a permanent renal fistula, and the other kidney is healthy.

2. Primary, only in unilateral cases, and if the other kidney can be proved to be healthy.

A. An obsolete pyonephrosis.

B. Chronic one-sided suppurative pyelo-nephritis that will not yield to prolonged medical measures.

C. Fulminating attacks of one-sided pyelo-nephritis with multiple abscesses or gangrene, when life is threatened by the disease.

In fulminating hæmatogenous infections of one kidney, apparently previously healthy, opinions are divided as to the better line of treatment.

In our experience these cases tend to recover from the acute attack very rapidly, if the patient be confined to bed, and given large doses of potassium citrate and a fluid diet.

Brewer and others bring evidence to show that many of these cases are fatal in the first five days, and that immediate nephrectomy produces a brilliant and absolute cure. It is impossible to prove that their cases would not have recovered without nephrectomy, as at present there are no certain signs by which the cases likely to prove fatal can be separated into a clinical group. The rapid sacrifice of a kidney seems hardly justifiable unless the surgeon can feel sure it is the means of saving life.

These cases therefore should be put to bed and watched *from hour to hour*. If after thirty-six to forty-eight hours the temperature is still very high the symptoms are increasing in severity, and death seems imminent, the surgeon may feel justified in exploring the affected kidney, but even then a preliminary drainage would seem preferable to immediate nephrectomy. On the other hand very few cases will be

found to run such a course, as most of them will rapidly subside under expectant treatment.

If the symptoms do subside, and the patient returns to comparative health but continues to pass large amounts of pus from one kidney, despite careful medical treatment, a complete investigation should be made of the whole uro-genital tract (see Ch. I). If the other kidney and the bladder are found to be healthy the affected kidney and ureter should be explored. Very often some predisposing cause can thus be discovered to account for the infection, such as an obstruction to the ureter by a stricture, kink, or an abnormal vessel. If this can be remedied and free drainage of the pelvis be re-established all may yet be well. If on the other hand the kidney is found filled with multiple abscesses, small and large, it will undoubtedly pay to remove it, as removal will relieve the uro-genital tract of a constantly recurring source of infection.

PYONEPHROSIS.

The term denotes a condition where the kidney has been hollowed out by back-pressure and destroyed by suppuration.

Ætiology.

There are two main groups of causes:

1. *Dilatation is primary,* a hydronephrosis becoming secondarily infected with bacteria.

2. *Infection is primary,* the ureter becoming blocked secondarily by the process of inflammation.

Causes of the first group are the same as the causes of hydronephrosis (see Ch. VI), and if the obstruction is ureteric the disease is unilateral, if below the ureter, bilateral. Infection may be descending or ascending (see p. 125). The common causes are ureteric stone, pelvic tumour, and urethral obstruction by enlarged prostate or stricture.

Causes of the second group are the same as the causes of renal infection (see p. 124), but chronic tuberculosis is by far the most common cause. Stones, though commonly present, are often secondary.

Pathology.

The kidney is embedded in a fibro-lipomatous mass, which may contain abscesses and fistulous tracks communicating with neighbouring cavities or the skin. When stripped out of its bed the kidney is seen to be greatly enlarged, the

surface granular and markedly lobulated, and the wall feels thin, tense, and fluctuant. On section, pus mixed with urine spurts forth, showing that the fluid is under considerable tension. The fluid varies from pale, thin, slightly turbid, urinous fluid to thick, yellowish-green pus.

In the hydronephrotic cases the cortex is so thin as to form a mere shell, with septa projecting inwards to surround loculi which correspond to the primitive lobules. This shell consists of fibrous tissue containing a few atrophied tubules and fibrous glomeruli, and is lined by a delicate, shaggy layer of granulation tissue. The pelvis is ballooned, and presents a similar appearance as does the ureter if the obstruction is below it. Secondary phosphatic calculi of large size and offensive odour may occupy the purulent chambers, and a small primary calculus may sometimes be seen partially blocking the upper end of the ureter.

In primary infective cases the appearances are rather different. The kidney is not necessarily much increased in volume. The cortex is thinned out in places, but considerable wedge-shaped areas of cortical tissue are still left in between large abscess-cavities lined by a thick layer of granulation tissue, the surface of which may be covered with membrane or plaques of phosphatic *débris*, and surround large, branched, secondary phosphatic calculi. The areas of cortical tissue are tough, fibrous, and fatty, and present linear streaks of pus or miliary abscesses. The wall of the pelvis is distended, tough, thickened, and lined by granulation tissue. The ureter is lined by granulation tissue and is embedded in a dense fibro-lipomatous mass which narrows or obstructs its lumen, and the lumen may be blocked completely by curdy *débris* or calculi. Peritoneal adhesions are sometimes present, and may even lead to intestinal obstruction; and fistulæ may be seen leading to the skin, gut, pleura, and lung.

A condition of partial pyonephrosis limited to a portion of the kidney is sometimes found, the causes being either a stone blocking a calyx or the presence of double ureters, only one of which is diseased.

If the ureter be completely blocked by a stone the kidney will shrivel up into a small fibrotic shell. Infection of such a kidney produces a condition closely resembling a pyonephrosis, save that the kidney is so small.

The bacteria found in the pus are in ordinary cases the *Bacillus coli*, *staphylococci*, *streptococci*, and the *Proteus Hauseri* (see p. 133), and in another class the *tubercle bacillus*.

Under the microscope, sections of the kidney wall show an inner lining of granulation tissue and an outer wall of altered kidney tissue. The tubules are dilated and contain pus, the epithelial cells are flattened out and degenerated. Bowman's capsules are thickened, and the Malpighian corpuscles are seen as mere fibrous relics. A large amount of fresh fibrous tissue is laid down between the tubules, and the connective-tissue spaces contain many leucocytes and round cells. The walls of the vessels and lymphatics are thickened and miliary abscesses are often seen scattered amidst the interstitial tissue.

In tuberculous cases the layers of granulation tissue are very thick and may present isolated giant cells, typical miliary tubercles, and scattered collections of small round cells.

Symptoms and Signs.

In primary hydronephrotic cases the patient may be aware that he has had an abdominal tumour for years, which may have caused no symptoms, or have led to attacks of "intermittent" hydronephrosis (see Ch. VI). Infection is signalised by the onset of rigors, fever, wasting, pain, and pyuria.

In primary infective cases the onset is that of an acute microbic nephritis (see p. 140), which becomes chronic, the course being marked by *periods of pyuria* during which other symptoms are in abeyance, interrupted by *periods of clear urine*, during which the general toxæmic symptoms rise into prominence, these periods corresponding to the intermittent patency and blockage of the ureter.

In tuberculous cases the onset is extremely insidious. Not uncommonly the patient states that he has been in complete health to within a few weeks of coming under notice, but then began to notice pain in the flank, accompanied by chills and sweating, and has since lost weight rapidly. If pressed he may state that he has been aware of a painless swelling in the loin for some years, and has noticed that the urine has been cloudy when passed. In these cases the onset of symptoms is delayed until the ureter becomes completely blocked, so that when they come under notice the urine *may be absolutely clear of pus or tubercle bacilli*, the only sign being a large renal tumour, accompanied by moderate fever, night sweats, and rapid wasting.

The general symptoms and signs are those of intermittent attacks of pyrexia accompanied by wasting. The local signs

are those of a large renal tumour, which may feel solid or cystic, is usually smooth, rounded and lobulated, and may be fixed or freely movable. The presence of a thickened contracted colon undergoing peristaltic movements to be seen and felt winding over the front of the tumour is pathognomonic of pyonephrosis, and is caused by the peritoneal adhesions. In acute cases the swelling is far less definite, is extremely tender, and can with difficulty be distinguished from a subdiaphragmatic abscess.

Pyuria is usually present, but may be absent, especially if the general signs are severe.

Course and Prognosis.

Removal of the obstruction followed by drainage, or nephrectomy in suitable unilateral cases, may lead to complete cure.

In the primary infective cases, especially the tuberculous, too often the infection has spread to the lower urinary tract and opposite kidney. In such cases, though much relief and prolongation of life may be expected from suitable treatment, yet the course is inevitably, but slowly, downwards, until death closes the scene from chronic uræmia or sapræmia. In other cases the cause is a pelvic tumour which cannot be removed, and will shortly destroy life.

Diagnosis.

A Pyonephrotic Tumour.

Such a tumour has to be distinguished first from other renal tumours, secondly from tumours of other organs (see pp. 61, 119). From hydronephrosis it is distinguished by the presence of general signs of sapræmia, and to a less extent by the presence of pyuria, and a marked polymorphonuclear leucocytosis may be an additional sign of some value.

In bilateral infections of the kidneys, especially the tuberculous, an enlarged tender kidney may be *an hypertrophied organ* only slightly infected, and not a pyonephrosis. Examination of the separated urines will usually decide this question, but failing that an exploration is the only decisive method. This fact is one ever to be borne in mind.

An infected traumatic perinephric extravasation of blood and urine simulates a pyonephrosis, but the history is suggestive, and the necessary operation settles the nature of the

swelling. The same is true of single gross abscess, and enlarged kidney the victim of diffuse pyelonephritis. The tumour has to be distinguished from tumours of the liver, gall, bladder, spleen, adrenal and gut (see pp. 61, 119), but the most difficult diagnosis has to be made from:

1. *Subdiaphragmatic* intra-peritoneal abscess.
2. *Perinephric* abscess.

1. An extra-cæcal and right or left hypochondriac peritoneal abscess may be suspected if there is a history of appendicitis, gastric ulcer or cholecystitis, and *if there is no resonance in front of the swelling.* The limits of the swelling are more diffuse, and no rounded outline like that of a kidney can be felt. The swelling is completely fixed, and does not move with respiration, and *the borders* are extremely tender.

2. A perinephric abscess bulges the loin backwards rather than forwards, and there is diffuse swelling and often redness and œdema of the tissues of the back of the loin. The swelling has a resonant band in front of it, but is absolutely fixed. Tenderness is usually extreme except in cases of cold abscess from a tuberculous focus in the spine, etc. (see p. 167).

For practical purposes the diagnosis is often made as follows:

The conclusion is reached that there is a large collection of pus in one loin which requires immediate operation. The swelling is incised, the pus allowed to escape, when gentle exploration of the wound with the finger or the eye, aided by a head-lamp and careful sponging, may reveal the origin of the abscess as renal, peri-renal, or peritoneal, but extensive search or rough manipulation must be sedulously avoided for fear of breaking down limiting adhesions. After a few days' drainage of the cavity the patient's condition improves, and careful investigation of the urine, the other organs, and the history may reveal the primary source of the infection. Healing may occur forthwith, or a second operation become necessary under more favourable circumstances to remove the primary infecting source.

In considering the diagnosis certain additional points must be determined:

1. *What bacteria are present?*
2. *What is the cause of the obstruction?*
3. *Is the disease unilateral or bilateral?*
4. *What are the relative powers and conditions of each kidney?*

5. *Is the lower urinary tract free?*

The bacteria are determined by bacteriological investigation of catheter specimens of the urine, and of the pus removed at operation, it being remembered that behind an infection with the *Bacillus coli*, etc., may lurk the *tubercle bacillus*.

The cause of the obstruction is determined by routine examination of the urethra, prostate, bladder, and the condition of the pelvic organs, and examination by X ray and the ureteric catheters, a special watch being kept to exclude stricture of the urethra or ureter, enlarged prostate, pelvic tumour and calculus, an examination which also serves to decide the last three questions.

Treatment.

The prophylaxis and the general palliative treatment have already been described on p. 150 on "Pyelo-nephritis."

A. Palliative Treatment is sufficient—

1. If the cause is one which cannot be removed and will of itself shortly put an end to life, such as a malignant pelvic tumour.
2. If the diagnosis from suppurative pyelo-nephritis is uncertain and drainage can be re-established by way of the ureter so that the results of a course of palliative treatment can be observed.

B. Operative Treatment.

This aims at removal of the cause, drainage of the infected cavities, and lavage by means of antiseptics, applied locally, and taken by the mouth.

1. *Nephrotomy, Nephrotresis : Removal of the Cause.*

Removal of the cause (*e. g.* stricture of the urethra, enlarged prostate, pelvic tumour, ureteric calculus) may be a primary or secondary operation. It should be secondary if the symptoms are urgent. Urgent symptoms can be relieved by simple incision and drainage of the kidney at a time when it is unwise to expose the patient to the risks of extensive manipulations of severely infected tissues. It should be primary if the symptoms are not urgent, when the kidney may be more thoroughly explored, loculi broken down, secondary calculi scooped out, and the ureter sounded.

Indications.

1. In bilateral cases on one or both sides, if the symptoms of pain and pyrexia are severe and the swelling or swellings are tense, tender, and increasing in size.

2. In unilateral cases—

(*a*) If the condition of the other kidney is not known.

(*b*) If the complete diagnosis has not been made, and a collection of pus is suspected, opened and explored.

Nephrectomy.

1. *Primary.*

In cases where the disease is known to be unilateral, especially in tuberculous cases, and the other kidney is known to be adequate, even though the bladder may be infected.

2. *Secondary.*

(*a*) After a primary nephrotomy with drainage for urgent symptoms, where subsequent examination shows that the disease is unilateral, is unlikely to be cured by drainage, and that the other kidney is adequate.

(*b*) For persistent fistula, spontaneous or operative, where the other kidney is adequate, and the presence of the diseased kidney is a source of danger.

CIRCUMSCRIBED ABSCESS OF THE KIDNEY.

Large circumscribed abscesses are very uncommon apart from pyonephrosis, bnt they are occasionally found either at operation or autopsy. They are always the result of bacterial infection and may take origin in one of the following ways:

1. *Dilatation behind a calyx blocked by a stone* (see Ch. V).
2. *Tuberculous infection* (see Ch. VIII).
3. *Pyæmic infarction* (see above).
4. *The confluence of many small abscesses* (see above).
5. *Suppurating localised hæmatoma caused by a blow* (see Ch. III).
6. *Suppuration in a cyst* (see Ch. XI).
7. *Suppuration around a foreign body such as a bullet* (see Ch. III).

Stone and *tuberculosis* account for the large majority.

Abscess may be single, or multiple. It often has a wall lined by a thick layer of granulation tissue surrounded by a dense outer fibrous ring, and is in the nature of a "cold" abscess. The organisms mostly found are the *Bacillus coli* or

the tubercle bacillus. The abscess may become inspissated, lie dormant, or burst in various directions, either towards the perinephric tissues, skin and viscera, or into the pelvis and ureter.

In acute cases there will be urgent pyrexial symptoms, but seldom either palpable renal swelling or pyuria, though there may be deep tenderness in the region of the kidney to lead the surgeon to suspect a deep abscess in the loin. The diagnosis can only be settled by exploration, or by spontaneous rupture of the abscess into the ureter or on to the skin. A cold abscess may only be discovered at the post-mortem, or at an exploration for renal calculus or one-sided renal pyuria. If an abscess be suspected, or discovered at operation, it should be laid open freely, some pus kept for bacteriological examination, and a finger inserted to explore for a lurking calculus. The kidney should be palpated all over for any further abscess, the cavity drained and the rest of the wound closed.

PERINEPHRITIS.

Perinephritis denotes an inflammation arising in the perinephric space which lies between the true kidney capsule and the two layers of the perinephric fascia containing the perinephric fibrous and fatty connective tissue.

Causes.

The exciting causes are bacteria, which may be bacilli of the colon group, streptococci, staphylococci, the *Proteus Hauseri*, and rarely the pneumococcus, gonococcus, influenza or typhoid bacillus, and as secondary agents anaërobes (Jungano); or the tubercle bacillus and very rarely the organisms of syphilis and actinomycosis. They reach the part in any of the following ways:

1. Primary Infection.
   - A. *Directly from the blood-stream.*
   - B. *From an open wound.*
2. Secondary Infection.
   - A. *Renal,* suppurative pyelo-nephritis.
   - B. *Extra-renal,* suppuration in adjacent organs.

Predisposing Causes.

Primary hæmatogenous infection arises in the states of lowered general resistance that follow the acute specific

fevers, or after a blow on the loin which produces a perinephric hæmatoma. Albarran found that by injecting bacteria into the veins of a rabbit's ear and then bruising the peri-renal tissues, he could produce peri-renal abscess.

Secondary infection is due to the wide anatomical relations of the connective-tissue spaces of the perinephric fatty tissue. The two layers of the perinephric fascia are attached to the diaphragm above, but are open below and across the middle line, and the laxity of the tissues in this space permits inflammation to spread rapidly and widely without setting up enough tension to lead to symptoms until the mischief is very far advanced. For instance inflammation arising in the pelvic cellular tissue around the rectum and neck of the bladder may quickly spread upwards behind the peritoneum along the ureter and into this space before causing general disturbance at all proportionate to the gravity of the condition. Infection need not necessarily spread by direct continuity along the connective tissue spaces. Another mode undoubtedly occurs, wherein the infection from such organs as the testicle and prostate spreads along the lymphatics and sets up suppuration in the juxta-aortic glands. The glandular abscesses burst into the perinephric tissue and infect it.

The following list includes the common primary sources of secondary infection of this tissue.

1. *Inflammations of the kidney* (see p. 124), especially those caused by calculus and tuberculosis.
2. *Inflammations and ulcerations of the gut,* colon, appendix, rectum and stomach.
3. *Inflammations of the pelvic and iliac cellular tissues* taking origin in the bladder, prostate, vesiculæ, testicles, uterus and vagina, etc.
4. *Osteo-myelitis of the spinal column,* tuberculous, staphylococcic, typhoidal, etc.
5. *Inflammations of the pleura and lung,* especially pneumococcal infections.

Pathology.

Morbid Anatomy.

1. *Simple Inflammation*—resolution.
   —fibro-lipomatous sclerosis.
2. *Suppurative Inflammation*
   —localised abscess or abscesses.
   —diffuse cellulitis—with multiple abscesses.
   —with gangrene.

Fibro-lipomatous sclerosis is produced by an inflammation of low virulence acting over a long period, usually of the kidney itself or of the ureter. It is common in tuberculous infections, but may be produced by other organisms, especially in calculous conditions. The diseased kidney and ureter are set in a dense mass of fibrous and fatty tissue of the consistency of cartilage, which invades the hilum and may even replace the kidney tissue entirely, and scattered collections of pus may be dotted about the section. The microscope shows dense bands of fibrillar tissue surrounding islands of fat cells, the spaces being filled with leucocytes and round cells, and the walls of the vessels being thickened and fibrous. Giant cells may be seen, especially in tuberculous cases, but are not common.

In diffuse cellulitis the blood-vessels are engorged, the tissue spaces filled with serum or pus, and scattered miliary abscesses or green and black gangrenous sloughs may be seen, especially when the infection is complicated by the entry of urine or fæcal matter into the tissue spaces, but such a condition may be caused by secondary anaërobic bacteria such as the *Bacillus perfringens* (Jungano). Gas is sometimes found, and is produced by similar bacteria or by a communication with the gut. Abscesses are often multilocular, the loculi communicating with one another by narrow necks or fistulous tracks that pass through the kidney substance or small holes in the fascia, so that a sharp look-out must always be kept for these in opening such abscesses.

The kidney may be healthy and lie loose in the midst of the abscesses, the wall being smooth or covered with granulation tissue, or discoloured by superficial gangrene. In other cases the kidney presents the appearances of a primary infective disorder.

The pus varies in consistency and colour, may be thin or viscid, white, yellow, or green, and mingled with urine, fæces, gas, blood, and gangrenous fluid.

An abscess around the kidney may spread in four directions, producing sinus tracks and fistulæ, which are as follows in the order of frequency:

1. *Upwards* to the diaphragm, pleura, lung, and bronchi, the abscess being eventually coughed up.
2. *Backwards* into the muscles of the loin, especially the psoas and quadratus muscles, bursting on the surface of the skin.
3. *Downwards,* either into the ureter, being discharged

with the urine; or into the iliac and pelvic cellular tissue to point at Petit's triangle, at the external abdominal ring, into the thigh as a psoas abscess, or into the rectum.

4. *Forwards* into the peritoneum and its contained viscera, especially the gut, liver, and spleen, bursting either into the gut or the peritoneum.

Symptoms and Signs.

The condition may reveal itself in three moods:

1. It may flare up quickly and suddenly as a well-defined acute abscess.
2. It may come on insidiously over a period of ten days to three weeks in the form of a diffuse spreading cellulitis.
3. It may appear as a "cold abscess."

1. The Acute Form.

The general symptoms are those of an acute infection, rigors, intermittent or sustained high temperature (103-104° F.), increased pulse-rate, leucocytosis, flushings, sweats, and rapid general wasting. The local signs are those of *irritable psoas, local abscess, and reflected pain.*

The irritable psoas shows itself in the following way: The lumbar spine is rigid and slightly bent towards the side of the abscess; the thigh is held slightly flexed upon the trunk and cannot be fully extended without pain; the patient walks with the body slightly bent forwards and to the affected side, and when standing may support his weight with one hand on the thigh of the affected side.

The local abscess is revealed as a rounded swelling in the back of the loin which bulges the loin backwards, and in "ripe" cases the skin is red, œdematous, and hot, the muscles of the back of the loin being rigid and tender. The lower limits of the swelling are indefinite and not shaped like the lower end of the kidney. The swelling is absolutely fixed in the back of the loin and percussion over it yields a dull note behind, continuous with the erector spinæ dulness, but resonant in front. The surgeon who awaits the sign of fluctuation waits too long.

Reflected pain is felt along the course of the nerves of the lumbar plexus which run through the inflamed area. The nerve-trunks are pressed upon or irritated, pain being referred

to the areas supplied by their terminations. These areas may show tender spots where the nerve-trunks emerge through the muscles to reach the surface. Morris has pointed out how the consideration of the position of these reflected pains may be evidence of the position of the abscess, whether it is high up or low down in the perinephric space.

The nerves affected are from above downwards, the last dorsal, the ilio-hypogastric, the ilio-inguinal, the genito-crural, and external cutaneous nerves.

The urine is clear, save for a trace of albumen caused by the febrile state, in primary or secondary extra-renal cases; but in secondary renal cases, or when the abscess has burst into the ureter, the urine will contain pus and bacteria.

Signs of inflammation in adjacent organs and cavities will appear as the pus tracks towards the various structures mentioned above. The bursting of pus into a serous cavity is preceded by a sero-fibrinous exudation, so that in a large majority of cases evidence is obtained of acute pleurisy with effusion, and of pneumonia at the base of the lung on the same side, or less commonly of diffuse peritoneal exudation. If the abscess is not diagnosed, or is left too long, it may open and discharge its contents into a bronchus, on to the skin, into the gut or peritoneum.

2. The Insidious Form.

This is especially likely to appear when the primary focus is the pelvis. The pyrexial and general symptoms are mild and indefinite for a week or ten days. The local swelling often declares itself first in the groins or in the pelvis, and may be considered sufficient to account for the mild degrees of pyrexia and the irritable psoas. The ease with which such inflammations can spread into the back of the loin should be remembered, and careful palpation will then reveal a diffuse tender swelling in this position.

3. The "Cold Abscess."

This declares itself as a fluctuating swelling in the loin, without redness, or heat, without much disturbance of the general health, and with very little pain. The pus tends to point along the edge of the erector spinæ, or along the course of the ilio-psoas muscle. Such abscesses, though often tuberculous and arising more often in the spine than in the kidney, may also be caused by other organisms. For

instance, the *Staphylococcus albus* is often found in them, and rarely the typhoid bacillus. They may arise from an osteo-myelitis or periostitis of the spine, or from a primary hæmatogenous infection following a blow on the loin.

If left to themselves perinephric abscesses may rupture on to the skin or into gut and spontaneous cure result, but usually they will cause death by rupture into the lung or peritoneum, by acute pyæmia or septicæmia, or by chronic sapræmia associated with an infected fistula or with the primary disease.

Diagnosis.

A. From other Inflammatory Swellings in the Loin.

1. *Pyonephrosis* (see p. 159), has a rounded lower end, is lobulated, usually moves with respiration, bulges forwards, and causes no redness and infiltration of the tissues of the back of the loin.

2. *Appendix or other intra-peritoneal abscess* may show no resonance in front, in which case the abscess is certainly not perinephric. If there is resonance in front there is no means by which the two swellings can be distinguished, apart from exploration, though the history often gives a good hint as to the probabilities.

3. *A distended inflamed gall-bladder*, fixed by peritonitis, presents in front rather than in the back of the loin, and yields a dull note to light percussion.

B. From other Causes of Flexion of the Thigh, and Pain in Back, Groin or Leg.

1. *Spinal caries.*—In this disease the spine seldom shows lateral deviation, but shows a diminution in the posterior lumbar concavity, and is rigid, and tender if jarred.

2. *Hip disease.*—In perinephric abscess there is no wasting of the thigh, no apparent lengthening, no abduction or eversion, and all the movements of the thigh are free and painless except extreme extension.

3. *Sacro-iliac disease.*—In perinephric abscess there is no swelling, heat, or localised deep tenderness over the sacro-iliac joint.

4. *From other causes of obscure pyrexia.*—In the early stages with insidious onset of pyrexia, and no local effusion of pus

felt to account for it, the disease is often labelled "typhoid fever." The absence of headache, the fact that the lung signs are unilateral, the more rapid pulse, the presence of a well-marked leucocytosis, and later the absence of positive Widal reaction, spots, etc., should be amply sufficient to exclude such a diagnosis.

c. What is the Primary Source?

Is it a blow followed by hæmatogenous infection or an open wound?

Is there any primary disease of the kidney, especially tuberculosis or calculus, as shown by the examination of the urine and radiogram?

Is there primary disease of other organs, *e. g.* of the pleura and lung, appendix, gall-bladder, spine, hip-joint, sacro-iliac joint, pelvic organs, etc.?

Clues to the primary source are often given by exploration or by the nature of the pus if it contains urine, calculi, fæces, or fæcal concretions.

Treatment.

The usual general treatment as for inflammation is employed.

The only effective *local* treatment is *early incision.* The practitioner is far more likely to operate too late than too soon. Even if no pus be found the early relief of tension will do good, and an abscess if missed will find its way into the wound after a day or two and evacuate its contents without danger and with good effect.

Exploratory puncture or aspiration through the soft abdominal wall are dangerous methods to employ in dealing with an *abdominal* swelling, and should never be used at the present day.

The skin is cleansed in the ordinary surgical manner, a general anæsthetic administered, and a free incision made into the peri-renal tissues from behind, exactly similar to that employed for the exposure of the kidney by the lumbar route.

If the cavity of the abscess be not opened at once, the edges of the wound are protected with gauze and a finger introduced to search for the position of maximum swelling; a pair of sinus forceps, being introduced along the fingers, are made to bore their way into the swelling until they strike pus, a specimen of which is retained for bacteriological investigation. The blades of the forceps are then separated, a finger

inserted into the abscess cavity, and its relations and contents explored. The opening is enlarged, the pus gently sponged out, and an attempt made to inspect the cavity aided by the head lamp. In this way fistulous tracks leading into secondary chambers or into the kidney itself may be detected, and the secondary loculi opened up. Any loose calculi or concretions are removed.

If the symptoms have been very acute, no further effort is made to determine and remove the primary source, a large rubber drainage-tube being left in to drain the depths of the wound, and the remainder loosely stitched up. In primary cases the abscess should heal up forthwith, but in secondary cases a fistula or sinus tends to persist until the primary cause has been attacked or removed.

At the first operation, if the symptoms are not acute, or at a second operation if a sinus persists or the primary cause be diagnosed, an effort should be made to attack the primary cause. A tuberculous kidney is removed in suitable cases, calculi are evacuated, and suitable treatment adopted for the various other conditions mentioned above.

The prognosis after operation is exceedingly good at the present day, the results of modern operation being far more hopeful than those published at the end of last century. This is due to better and earlier diagnosis both of the existence of perinephritis and of its primary causes, and to the fact that the operation is usually performed earlier and in two stages, a primary drainage being followed by a secondary operation to remove the cause.

In primary cases complete healing should be the rule in two or three weeks and the mortality should be practically *nil*. In secondary cases, if the primary cause cannot be removed, a fistula may be left or the patient may die of the primary disease itself.

RENAL FISTULA.

Causes.

1. *Accidental open wounds.*
2. *Deliberate surgical wounds:*
   (*a*) *temporary.*
   (*b*) *permanent.*
3. *Renal suppuration.*
4. *Peri-renal suppuration.*

Certain conditions must be present to determine a renal

fistula. A communication must exist *between the renal pelvis* and the surface of the body, either direct or through the renal cortex; mere exposure of the *cortical substance* is not sufficient. Such a communication can only be prevented from healing first by the presence of a foreign body such as a stone or a silk ligature, secondly by the existence of some obstruction to the natural ureteric outflow, thirdly by the presence of chronic suppuration. Accidental wounds of the pelvis quickly heal if they are adequately cleansed, freed from foreign bodies, and drained. Deliberate surgical wounds seldom fail to heal if all foreign bodies have been removed, such as calculi and silk ligatures, if there is no obstruction to the ureteric outflow, and if adequate drainage of all the infected parts can be established. Fistulæ will only remain permanent if the cause of ureteric obstruction or renal infection cannot be removed—as in a tuberculous pyonephrosis when nephrectomy is contra-indicated by the condition of the opposite kidney; or if a fistula be established deliberately, as, for instance, in complete extirpation of the bladder for carcinoma. Renal and peri-renal suppuration can lead to a spontaneous fistula.

In cases of fistula from tuberculous suppuration, if secondary infection is allowed to occur, the fistula is not likely to close and the patient dies exhausted by amyloid disease in six months to a year, whereas in other cases of renal suppuration, if foreign bodies are removed and ureteric outflow is free the fistula will close readily.

Peri-renal suppuration may cause a fistula by the simultaneous bursting of an abscess into the pelvis and on to the skin or on to some other surface; or it may have been produced by a primary infection of the kidney itself, in which case a fistula is very likely to arise.

Where the abscess bursts a fistula presents as a narrow, winding track, which may open out in places into large chambers and pockets in the kidney itself and in the surrounding tissues. The tracks and openings may be multiple, their wall being formed by an inner layer of granulation tissue and an outer layer of fibrous tissue. Internally the tracks open directly or through the cortex into the pelvis. Externally they open on to the skin in the back or side of the loin, or rarely, in the groin; into the lung and bronchi; or into any part of the gut, usually the colon. Lung fistulæ are rapidly fatal; intestinal fistulæ are sometimes cured with difficulty by suitable treatment.

The fluid in the tracks may consist of clear urine, pus and

urine, or fæces, pus and urine; if of pus alone the condition is one of sinus rather than fistula.

Pathogenic bacteria are nearly always present in the escaping fluid, such as the tubercle bacillus, the *Bacillus coli*, and the other infective bacteria (see p. 133), and any number of secondary contaminating organisms, aërobic and anaërobic, which render the task of purification more difficult.

In considering the diagnosis the following questions press for an answer:

1. Is the condition one of sinus or fistula? What are the positions, numbers, and communications of the tracks? And is the communication with the pelvis or the ureter?

2. What is the primary cause? Accidental wound, foreign body, ureteric obstruction, or primary infection of the renal or peri-renal tissues?

3. What are the bacteria present? And which are primary and which secondary?

4. What is the state of each kidney, anatomical and functional?

In answering these questions help may be obtained from the history, the positions of the openings on the skin, the detection of urine in the escaping fluid as shown by the presence of an ammoniacal odour, phosphates, urea, uric acid, etc.; the detection of intestinal contents in the fluid; the history of a renal tumour which disappeared simultaneously with the discharge of pus and urine either in the fæces or in the sputum.

Coloured fluids such as aqueous fuchsin injected into the sinus mouth may appear in the bladder-urine if the ureter be pervious, but if the ureter be impervious a methylene blue pill administered by the mouth will lead to a blue secretion from the external opening.

The passage of ureteric catheters and the collection of the urine escaping through the fistula will reveal the functional state of each kidney, the nature of the bacteria present, primary and secondary, and the position of any obstruction in the ureter. Coloured fluids may be injected in this way, and recovered from the external openings.

Fluids impervious to the X rays, such as collargol solution, may be injected, and attempts made to map out the fistulous tracks by means of the X rays, the presence or absence of calculi having been previously determined by routine X-ray examination.

Treatment.

Modern treatment aims at preventing fistulæ, by earlier operation for calculus, ureteric obstruction, tuberculosis, and other renal infections, and by taking care that the ureter is pervious, and that no foreign bodies are left behind in the wound.

Temporary Fistulæ.

Attempts at closure may be made by measures short of operation. The external opening is kept surgically clean by careful dressings, and the provision of a suitable covering, and adequate drainage; antiseptics are applied locally, or taken by the mouth, and suitable vaccines prepared and used. Attempts to drain the ureter by a catheter *à demeure* are seldom attended with success.

If such measures fail to close the fistula, or if foreign body, ureteric obstruction, or chronic renal infection are diagnosed or suspected, an operation should be undertaken. The sinus tracks are scraped out, flushed with antiseptics, and plugged with gauze, the skin is disinfected, and the kidney thoroughly exposed by a lumbar incision, which should surround and lead to the excision of the fistulous tracks. Calculi and other foreign bodies are removed, ureteric obstruction relieved by nephropexy and plastic operation, abscess cavities opened up and drained. If the opposite kidney is healthy nephrectomy is performed for a tuberculous kidney, or one hopelessly disorganised by suppuration. Rubber drainage-tubes are inserted and the wound partially closed. With careful after-dressings healing should seldom fail to occur. If the fistula is known to be incurable or meant to be permanent a suitable apparatus should be applied to catch the urine and other discharges.

CHAPTER VIII.

TUBERCULOUS INFECTIONS OF KIDNEY AND URETER.

For surgical purposes we exclude—(1) miliary tuberculosis of both kidneys arising in the course of a generalised miliary tuberculosis. (This is the usual form in children.) (2) The chronic interstitial nephritis of those succumbing to severe extra-urinary tuberculous lesions. (3) Instances in which bacilli are passed by both kidneys in the absence of pus-cells by those cases suffering from advanced tuberculosis of other organs.

Certain old ideas in connection with this subject call for revision, namely, that tuberculosis of the kidney is an uncommon disease; that it is part of a general disease; that it is frequently an ascending infection from the bladder region; that it occurs in women rather than men, on the right side rather than the left; that it is wrong to perform cystoscopy on males who present symptoms of tuberculous cystitis, without palpable tuberculous nodules in the genital organs.

Recent study of pathological and clinical records have served to establish the following important facts:

The disease is very common; it occurs in young adults, in men even more often than women, and affects either side. It is a one-sided, local disease at first in the vast majority of the cases (85 to 90 per cent.), and tends to remain so for a long time (one to seven years).

Ascending infection is rare.

Hæmatogenous tuberculous infection of the uro-genital tract occurs primarily in the kidney in both sexes, and in men in the epididymis, and tends to *descend* to the bladder-neck from both sources. A kidney focus is often the only, or at least the only important focus of tubercle present in the body when the patient is first seen. The symptoms intermit and become latent in the most remarkable manner, even for several years, lulling the practitioner into a delusion of cure. Spontaneous healing does not occur, though slow spontaneous

destruction ("Nature's nephrectomy") is common. Finally, *removal of the primary focus in the kidney in a large majority of the cases provides an absolute cure.*

Ætiology.

The exciting cause is the deposit in the tissues of the kidney of the tubercle bacillus of Koch. This commonly reaches the kidney by way of the blood-stream—"hæmatogenous infection"—rarely by ascent along the walls of the ureter from a focus in the wall of the bladder or vas deferens—"ascending local infection."

Hæmatogenous infection may be "protopathic," no lesions existing elsewhere (Orth has shown that the tubercle bacillus can pass through healthy mucous membranes into the blood without exciting a demonstrable local lesion); or it may be "deuteropathic," primary foci already existing in the lungs, bones, joints, and other organs. The disease spreads sooner or later to the ureter and bladder, in the urine stream, by direct continuity of tissue, or by the lymph or blood-stream.

Ascending infections reach the kidney along the walls of the ureter, or in the urine itself when the valvular mouth of the ureter is thickened and rendered incompetent by tuberculous disease. This disease may have spread from a primary hæmatogenous focus in the wall of the bladder, or more often in men from a primary hæmatogenous focus in the epididymis and vas deferens. It occurs therefore only late in the disease, and when evidence of epididymitis and bladder-neck disease can be easily demonstrated without cystoscopy.

A double hæmatogenous infection of epididymis and kidney may co-exist, as can be demonstrated clinically by the fact that the vas deferens, bladder-walls, and lower ureter are still unaffected—an important clinical state to be recognised.

The tubercle bacillus anchors from the blood-stream in two ports, first the kidney, secondly the epididymis, and starts forth on its journey in the uro-genital regions. Being a slow organism it seldom ascends, but prefers to descend. Its highways are the ureter and the vas deferens. It comes to the cross-roads in the wall of the bladder where the ureter crosses the vas deferens, and there rests for a time in the wall of the bladder around and above the ureteric opening. From this point it sets out afresh to explore the peninsulars, sometimes continuing upwards along the other high roads (vas or ureter), or more commonly entering on by-paths, the vesiculæ, prostate, bladder-wall, and very rarely the urethra.

This conception gives the key to successful treatment—*to remove the primary focus (kidney or testicle) before the secondary deposits have become too extensive.* After removal of the primary focus, the secondary deposits melt away under the influence of tuberculin and general tonic treatment.

The second kidney is rarely affected simultaneously, and in 60 per cent. of the autopsy cases it is still found free from tuberculosis. After months or years in some cases it does become infected, either by means of a fresh hæmatogenous infection, or by ascent from the bladder or vas deferens. It is often damaged by the presence of disease in the opposite kidney, and gives evidence of a non-specific degenerative change or "chronic nephritis," which may subside after nephrectomy on the diseased side. Such a damaged kidney is a *locus minoris resistentiæ,* and is thus predisposed to hæmatogenous infection with the tubercle bacillus.

Predisposing Causes.—The following have been accused, though with what justice is difficult to say:

Blows on the loin, retention of urine, "movable kidney," gonorrhœa, excessive use of the sexual organs. The idea that right-sided "movable kidneys" in women were frequently attacked is found not to hold in the more recent statistics.

Sex Incidence.—All the more recent figures seem to show that the kidney of the male is more frequently attacked than that of the female. This has been masked in the past by the fact that, taking nephrectomy cases for tuberculosis, 60 to 70 per cent. were women. There are two reasons for this: first, there has until recently been a reluctance to cystoscope males with symptoms of bladder tuberculosis; secondly, because males often have a second infection of the testicle and there has been a reluctance to perform nephrectomy in such cases.

It is now becoming the rule to cystoscope all cases suspected of uro-genital tuberculosis, and to remove the kidney in every case if a one-sided hæmatogenous infection of that organ can be proved.

Pathology.

Morbid Anatomy.

Hæmotogenous Forms (as removed at operation).

1. *Fibro-caseous or Cavernous Form.*

This is by far the most common form found at operation.

The surface of the kidney may be smooth and to all appearances healthy; or may present a group of miliary tubercles marked during life by fibrous adhesions to the fatty capsule. On section, one or more caseating nodules are revealed at the junction of medulla and cortex, surrounded by a thick layer of granulation tissue and a fibrous capsule. They appear first at the upper or lower poles; later they are seen also in the middle zone. Around the main nodule lie scattered miliary tubercles distributed outwards along the blood-vessels and becoming subcapsular. The whole area of disease is wedge-shaped and is clearly distributed along the course of a lobular artery, suggesting tubercular infarction. One or more of these caseous nodules will be seen to have burst into the pelvis of the kidney and discharged its contents, leaving a cavity lined by tuberculous granulation tissue. Rarely a nodule bursts into the perinephric tissues and leads to a large perinephritic abscess.

In their later stages these cavities increase in size and large phosphatic calculi may occupy their lumen or masses of chalk be deposited in their walls.

Secondary infection, or rarely, the onset of neoplasm, may also alter the picture.

2. *Pyonephrosis.*

This is a large kidney surrounded by a fibro-lipomatous envelope formed by the indurated perinephric tissues. The ureter is infected, its walls ulcerated and thickened, and more or less completely blocked. The pelvis is dilated, its walls lined by granulation tissue. The kidney substance has been distended, thinned out and destroyed, being converted into a fibrotic mass holding large tuberculous cavities and secondary phosphatic stones.

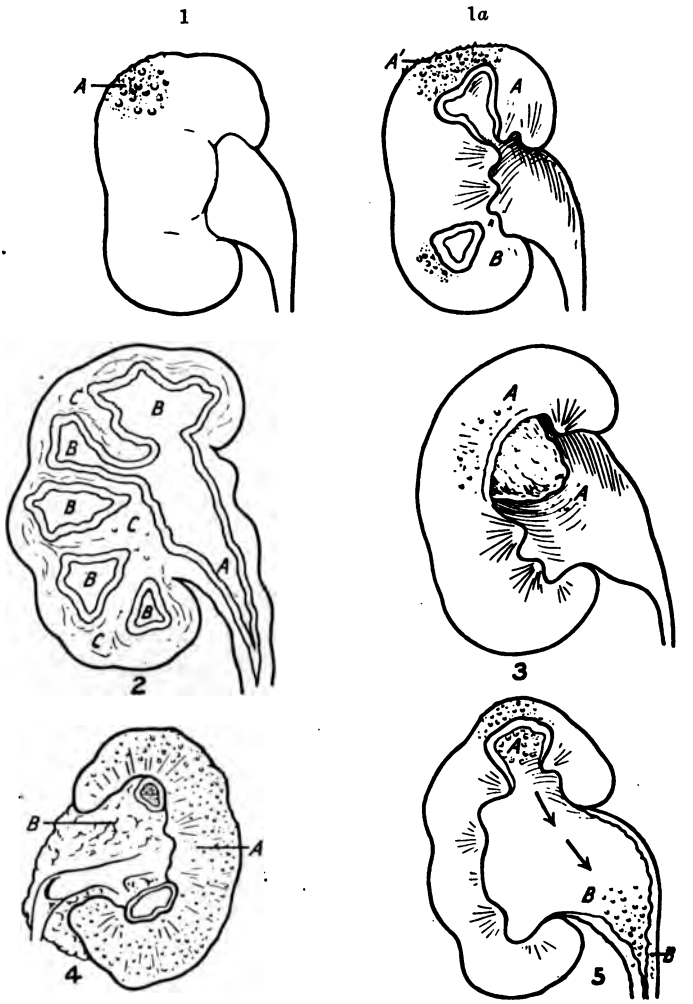
This form is derived from the first form by the bursting of a primary renal nodule, followed by early infection and blocking of the ureter.

Uncommon Forms.

3. Miliary hæmatogenous tubercles appear in the submucous tissue covering one or more renal papillæ, become confluent and caseous, and form ulcers which invade and destroy the pyramids, a form associated clinically with profuse hæmaturia.

4. The tubercle bacillus is deposited in the interstitial tissues

PATHOLOGICAL TYPES OF TUBERCULOUS KIDNEYS.



1. Early tuberculosis (unopened kidney). On the surface everything healthy except patch A, where capsular adhesions have had to be torn away, revealing grey miliary tubercles on the cortical surface.

1*a*. The same kidney cut across. A. A wedge-shaped cavity lined by tuberculous granulation-tissue, which has discharged its contents into the pelvis. A'. Patch of cortical miliary tubercles, and capsular adhesions. B. A wedge-

throughout the whole kidney and leads to a diffuse interstitial sclerosis, with scattered tubercles and without caseation as a prominent feature.

5. The ureter is chiefly affected, its walls thickened, its lumen lined by tuberculous granulation tissue, and blocked. The kidney forms a hydronephrosis, with perhaps a few scattered nodules in the pelvis or small nodules at one pole in the parenchyma.

Secondary Ascending Forms (as removed at Autopsy).

There is advanced tuberculosis of epididymis, vas deferens, and bladder. The walls of the ureter are thickened, and submucous miliary tubercles can be followed up the ureter into the lower portion of the pelvic mucous membrane to a tuberculous ulcer of one or more of the *lower* pyramids. Later still all the pyramids are attacked and disappear, leaving a ragged cavity lined by the cortex of the kidney, the interstitial tissues of which contain numerous miliary tubercles between the tubules and spreading to the perinephric tissues.

In all but the early cases the perinephric and peri-ureteric fibro-fatty capsules become fibrotic and *shrink*. The kidney tends to be pulled up under the ribs, and the mouth of the ureter in the bladder is pulled out to assume the form of the external abdominal ring or a golf-hole.

The ureter is seldom infected primarily, but becomes involved secondarily from a focus in the kidney, vas, or bladder. The opposite kidney may show early degenerative changes or may be amyloid, or it may show deposits of tuberculous material. The juxta-aortic lymphatic glands may become infected, and set up perinephritic abscesses and fistulæ.

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shaped tuberculous deposit, *still latent*, neither showing on the surface nor having burst into the pelvis.

2. Tuberculous pyonephrosis. A. The ureter is lined by tuberculous granulation-tissue, and is partially blocked. B. Large abscess cavities lined by granulation-tissue. C. Kidney substance changed into a fibro-lipomatous mass.

3. Tuberculous ulcer of renal papilla (A, A).

4. Diffuse interstitial form. A. Miliary tubercles scattered diffusely, interstitial tissue much increased. B. Pelvic fat changed into a dense fibro-lipomatous mass.

5. Tuberculous hydronephrosis. A. Small primary nodule in cortex. B. Secondary infection of upper end of ureter causing partial blockage and nephrectasis.

Histology.

The tubercle bacillus pierces the walls of the capillaries of a lobular artery in many places simultaneously and proceeds to multiply in the interstitial tissue between the tubules. Fluid and round cells are exuded, and the interstitial cells multiply so that a mass of spindle-cells and round cells is formed containing one or more "plasmodia" or "giant cells," the tubules being pushed aside or digested and destroyed. These masses become confluent and break down in the centre into a cheesy or purulent mass of *débris*, bounded by a layer of granulation tissue containing giant-cell systems and tubercle bacilli. Outside this area again are formed isolated giant-cell and round-cell systems in the intertubular spaces extending outwards to the capsule, which shows multiplication of fibroblasts with the formation of fresh fibrous tissue infiltrated with round cells.

Morbid Physiology.

The effect on the body for a long time is but slight, the local focus seeming to cause little toxæmia, so that cachexia and wasting are absent and the patient looks healthy and well.

Later in the disease toxæmia does occur, giving rise to intermittent pyrexia, wasting, cachexia, and amyloid disease.

No blood-pressure-raising substances appear to be produced, as clinically the general blood-pressure is nearly always low, or, if produced, they are neutralised by the tuberculous toxins.

The opposite kidney at first shows little change, but sooner or later it undergoes degenerative changes presumably produced by the action of circulating toxins and shows clinical signs of disease in the way of depressed function. These changes may regress after removal of the tuberculous kidney or may progress.

Bacteriology.

Not only may the tubercle bacillus be present, but other organisms may reach the damaged kidney, especially the *Bacillus coli*, and the staphylococci and streptococci.

Clinical Features.

I. Uro-genital System.

A. *Symptoms.*

(1) *Pain* is an early sign in the majority of cases, but it may be absent until the very last stages, *especially in cases of pyonephrosis.* When present it is often a *misleading sign,* as it is felt in regions remote from the kidney.

Bladder pain in the early stages is the most characteristic pain, the neck of the bladder being irritated by the tuberculous urine from the affected kidney, *though the bladder itself is still uninfected.* This is a cramping pain deep in the perinæum or at the end of the penis, felt just at the finish of micturition, rather sharp for some minutes, then passing into a dull ache which subsides before the next act. *This pain, combined with increased frequency of micturition and hazy, acid urine, is highly suggestive of tuberculous kidney*; a fact which cannot be too clearly emphasised. *It is a signpost which points to cystoscopy, nephrectomy, and absolute cure.* In a week or two the signs disappear, the urine clears, and the disease enters on a *latent stage* of some months' duration, during which the kidney is preparing another caseous "bomb-shell." When this bursts into the pelvis, another short period ensues of bladder-irritation and hazy urine. These attacks may be repeated over a period of two to seven years, yet the bladder remains free; but all the time the kidney is slowly but surely being destroyed.

Renal pain, when present, is a dull, one-sided lumbar ache, little influenced by rest, movement, or position, worse at night and during menstruation, when the kidneys are flushed with blood.

"Renal" or ureteric colic is occasionally observed, caused by the passage of cheesy masses down the ureter (see p. 82).

Frequency of micturition is much increased both by night and by day. In the earlier stages this is often the only sign. *Persistent nocturnal frequency in a young man warns of tuberculosis.* It is due to a variety of causes, such as the early polyuria, the irritated, infected, or contracted bladder, the reflex irritation of the kidney by deposits in its substance.

Pyuria or hazy urine may be noted by the patient.

Hæmaturia may be the onset symptom in exceptional cases; sudden in onset, profuse, lasting some days, and with or

without pain. It seldom persists, nor does it often appear later in the course of the disease, unlike the hæmaturia of calculus.

B. *Signs.*

Abdominal, rectal, and vaginal examination.—No palpable renal tumour should be expected in the early stages, when nephrectomy can cure. The kidney which contains one or two caseous nodules the size of a walnut is doomed to destruction and should be removed, yet it is *not enlarged* by such small amount of disease. The practitioner *cannot then expect to feel* the kidney, but should trust to other signs in making an early diagnosis.

In the later stages the kidney may be slowly eaten away without ever becoming enlarged, but more often it is distended by intermittent ureteric block and set in a fibro-lipomatous mass of inflamed perinephric tissue so that a tumour is felt in the loin, which may continue to move with respiration though it is surrounded by dense perinephric adhesions. At times a vast pyonephrosis is formed filling half the belly. *At the same time it should never be forgotten that the healthy kidney may undergo hypertrophy and feel like a large renal swelling, the diseased kidney being small and obsolete. This healthy kidney may also be tender.* Unless attention is paid to the results of ureteric catheterisation, the healthy kidney may be explored and even removed, with disastrous results—a fact that should be ever present in the mind when examining a case of tuberculous kidney.

A tuberculous kidney may be tender on deep pressure, but just as often *it is not so.*

The ureter becomes infected sooner or later and its thickened walls can then be felt, either deep in the lumbar pouches or *through the walls of the rectum or vagina.* No sign is of more value than this though it is not quite specific.

In the male nodules in the vesiculæ seminales and prostate may be felt by rectal examination, and afford valuable diagnostic hints. The same is true of deposits in the epididymis and spermatic cord.

Rarely the thickened bladder-wall can be felt in late cases, and in the female the "thimble" bladder is characteristic (see Ch. IV, Sect. III).

Tuberculous ulceration of the urethra, glans penis, and scrotum is sometimes observed in the last stages.

The Urine.

Polyuria is constantly found in the early stages, especially at night. It may be due to reflex irritation of the renal nerve-endings, to destruction of the water-absorbing tubules (if such exist), or to the concomitant bilateral interstitial "nephritis." It accounts in part for the increased frequency of micturition.

In the last stages, when most of the renal substance has been destroyed, there is oliguria.

The specific gravity is lowered to 1010–1015, the pigment is diminished and the urine pale.

"*Pus in acid urine*" is often said to be pathognomonic of tuberculous kidney, forming a haze which settles down as a white deposit in the specimen glass, the microscope revealing leucocytes and tubercle bacilli. At the same time *pus in acid urine may be found in cases of pure renal infection with the Bacillus coli or a streptococcus, or these same organisms may be present as secondary infective agents and mask the presence of the tubercle bacillus.*

Pus in its appearance is intermittent or remittent, its presence in large amounts marking the periods of explosion of the caseous "bomb-shells" into the renal pelvis, its absence marking the periods of ureteric block.

Alkaline urine means the presence either of secondary infective organisms (such as staphylococci, the *proteus*, etc.), or of excess of alkaline phosphates.

Blood is rarely found in the late stages, but is not uncommon at the onset, and when present appears in large amounts, intimately mixed. It is associated with superficial ulceration of the pelvic mucous membrane covering the pyramids, or with a general congestion of the kidney in response to the irritation of the tuberculous poisons. A few cases of so-called "symptomless," "essential," or "painless hæmaturia" turn out to be early tuberculous infection of one kidney. We may repeat again the maxim that *hæmaturia calls for cystoscopy, not for drugs and delay.*

Albumen may be absent, or if present may be due to the presence of pus or blood. The affected kidney may pass less albumen than the non-affected kidney. Albumen from the non-affected kidney means a secondary toxic nephritis, and may disappear after nephrectomy on the diseased side.

Casts, when present in large numbers, are caused by the secondary toxic non-specific nephritis rather than by the tuberculous disease.

Micro-Organisms.

The finding in the urine of the *tubercle bacillus of Koch accompanied by pus cells* is the only absolute and unequivocal sign.

Patients with advanced tuberculous lesions in the lungs or elsewhere may excrete tubercle bacilli in the urine. These may pass through the kidney, first without exciting any damage (Sherrington); secondly, exciting an interstitial, or even parenchymatous nephritis (Jousset, Walsh); thirdly, lodging in the renal tissues and setting up tuberculous deposits. In the last case only do pus cells appear in the urine in sufficient numbers to be noticeable. *Surgical tuberculosis of the kidney is therefore marked by the presence of both bacilli and pus cells in the urine.*

Great caution must be exercised in obtaining the urine for this examination. As yet the bacteriologist is not prepared to distinguish the tubercle bacillus from the bacillus of smegma by staining methods alone. The smegma bacillus must therefore be excluded. It lives on the glans penis and foreskin, and also on the surface of the penile urethra in the first few inches of its course (Young).

The glans penis or vulva should be cleansed for some minutes with swabs and hot soap and water. In a man the penile and bulbous urethra should then be flushed out by means of a urethral nozzle, using some four pints of plain, warm water. The patient can then pass water direct into a sterile flask, or a clean catheter can be passed into the bladder and the urine withdrawn into a similar flask. The first method possesses rather less risks, but is unsuitable for use in females.

Examination is made of stained films of the centrifugalised urine, and in doubtful cases guinea-pigs should be inoculated with it beneath the skin of the groin. The latter method will yield a definite answer in three to six weeks; the former, however, usually suffices for practical purposes if the smegma bacillus has been excluded.

In all cases the urine should be drawn off from each ureter, and examined first for tubercle bacilli and pus-cells, secondly for an estimation of the functional value of each kidney and signs of secondary nephritis.

There has been much hesitation in accepting this statement as an absolute rule of practice, as on *à priori* grounds it was thought unsafe to catheterise the ureter of "the healthy"

kidney across a bladder that has recently contained tuberculous urine. It has been found by experience that the risks of infection are far less in practice than the risks encountered if this examination is not made. Without it the surgeon does not know for certain which is "the healthy" kidney, nor does he know if it will suffice for the needs of the body after nephrectomy on the other side. Many disasters appear in the literature, and many more have not been reported, caused by a neglect of this rule.

Kapsammer has performed upwards of fifty bilateral ureteric catheterisations across an infected bladder, and though following his cases carefully, has never noted consecutive infection of the healthy ureter; but he has always been careful to follow certain essential rules, which may be amplified and summed up as follows:

1. The ureteric catheters are rendered sterile.
2. The bladder is emptied and filled with mercury oxycyanate (1 : 2000).
3. The catheters are made to enter the ureters at once without any preliminary fumbling round the bladder wall.
4. The catheters are passed no further than two inches upwards.
5. Before removal, half an ounce of a 1 per cent. solution of corrosive sublimate are injected through the catheters.

In this connection it should be noted that Albarran attributes his latest remarkable results in nephrectomy for tuberculous kidney (108 cases, 3 deaths) to these two facts: first, *that he operates so early*; secondly, that he *never operates without satisfying himself of the functional value of both kidneys separately* by means of ureteric catheterisation.

Most authorities agree that any form of separator or segregator is not to be relied upon in diagnosis, and presents more dangers than those incidental to ureteric catheterisation in the hands of an expert in both methods.

II. General Signs and Symptoms.

Anæmia, wasting, and cachexia are not observed for many months or even years in the average case, so that the patient may look rosy, plump, and well, and fever be absent.

In the later stages and in severe infections the "hectic" condition supervenes. The temperature is intermittent, being subnormal at certain periods of the day and raised to 100–

103° F. at other periods. These phases are produced by auto-inoculations with tuberculous poisons and mark periods of "positive" and "negative" phase. Rest in bed often causes their complete disappearance for a time. With these signs go stages of flushings and sweats, and the body slowly wastes.

With the onset of secondary infection pyrexia and wasting grow increasingly severe, and amyloid disease soon becomes a feature.

There is no hypertrophy of the heart muscle nor any rise in the general blood-pressure, which on the contrary is often remarkably low (95 to 105 mm. of mercury).

Death is certain within one to ten years, apart from early nephrectomy. Spontaneous "cure" is unknown, though the disease may run a slow course with long periods of intermission. Death may be (1) *renal* from anuria or uræmia, or (2) *general* from cachexia, toxæmia, septicæmia, generalised tuberculosis, or amyloid disease.

Diagnosis.

The earlier the diagnosis, the better the chance of nephrectomy and cure.

Early diagnosis has been one of the two main reasons for modern success in treatment, but even at the present day the diagnosis is often missed until too late or is made at autopsy. Kapsammer quotes 192 consecutive cases of tuberculosis of the kidney taken from the Vienna post-mortem records, of which 185 had not been diagnosed correctly and 67 *were still one-sided.*

Three points have to be distinguished in diagnosis:

1. *The specific nature of the disease.*
2. *The seat of the disease,* whether confined to one or both kidneys, or existent also in other parts of the urinary tract, and of the body in general.
3. *The differential diagnosis* from other conditions which resemble tuberculosis.

1. THE SPECIFIC NATURE OF THE DISEASE is proved by finding the bacillus of Koch (see above, p. 184, Ch. VIII), and if pus-cells are present as well the condition calls for surgical measures. The presence of secondary infective agents such as the *Bacillus coli* often masks the presence of the tubercle bacillus for a time. The injection of tuberculin, the Calmette ophthalmo-reaction, and the tuberculo-cutaneous reaction, if

obtained, merely suggest that tubercle is present somewhere in the body, and moreover, they fail at times to give a reaction in patients proved to have tuberculous kidneys. Marked fluctuations in the tuberculo-opsonic index when the patient does hard work may yield indications of higher value, but the diagnosis can be established more easily by other methods.

2. THE SEAT OF THE DISEASE.

(a) *A kidney* (one or both) is proved to be infected by examination of the urine obtained by the ureteric catheters. Palpation and the X rays seldom, if ever, provide sufficient evidence for proof, but ureteric meatoscopy may yield considerable evidence.

With the cystoscope in the early stages may be noted swelling and reddening of the mouth of one ureter, or around it a condition of "œdema bullosum," ecchymoses, tuberculous nodules, ulcers. Later on the shape of the opening is altered, the outer edge being drawn outwards so that the ureter resembles the shape of the external abdominal ring, or becomes like a golf-hole or crater. These appearances are produced by the drag of adhesions around the kidney or ureter. One ureter may be seen to puff out a cloud of pus from time to time, whereas the efflux from the other ureter is clear.

(b) *Tuberculous foci in other parts of the urogenital tract* are revealed by palpation of the testicles, and of the base of the bladder and lower ends of the ureter by rectal and vaginal examination, which should never be omitted. Such foci render valuable aid in diagnosis, and need to be considered in planning treatment.

(c) *Tuberculous foci in other parts of the body* should always be searched for by the ordinary methods of examination, especially in the lungs, the bones, the joints, and the lymphatic glands.

3. DIFFERENTIAL DIAGNOSIS.

Tuberculosis of the kidney can be mistaken for the following conditions:

Renal and ureteric calculus.
Other specific infections of the kidney.
Neoplasm.
Chronic cystitis, posterior urethritis, prostatitis.

(a) *Renal and ureteric calculus.—The pains* may be the same, though colic is more common in calculus, and the pain is often relieved by rest, whereas the pain of tubercle persists

at night. *Hæmaturia* may be an early symptom in tuberculosis, but seldom persists after the first attack. Hæmaturia is recurrent in calculus, and is brought on by exercise or violence.

Pyuria is absent in calculus perhaps for years, yet when present it tends to persist and increase, whereas pyuria in tuberculosis appears from the first, but is intermittent.

Radiographs usually show the presence of stone, yet at the same time large phosphatic calculi may appear in old tuberculous cavities, and calcareous *débris* and plaques may yield shadows.

The presence of the tubercle bacillus in the urine is the only certain sign.

(b) *Other renal infections; pyelo-nephritis.*—The chronic forms simulate tuberculosis very closely, and can only be distinguished by careful bacteriological examination. The acute forms start with severe pain in both loins and well-marked pyrexia, rigors being common. Bacteriological examination of the urine reveals the colon bacillus or other pyogenic organisms.

(c) *Neoplasm.*—Those rather infrequent cases which start with a profuse painless hæmaturia simulate neoplasm, but they are recognised by the finding of pus-cells and tubercle bacilli in the urine.

(d) *Chronic cystitis due to stone* is distinguished by means of the cystoscope, *due to nervous disorder* by routine examination of the nervous system.

(e) *Posterior urethritis and prostatitis*, gonorrhœal in origin, are distinguished by a careful history, by the use of the glass tests, and by bacteriological examination.

Common Types.

Certain clinical types can be recognised as the cases present themselves for their first examination.

1. *The "cystitis" type, "the scalded bladder."*—A young adult, male or female, complains of increased frequency of micturition, and scalding pain deep in the perinæum or at the end of the penis at the close of the act. There is no venereal history. Pus is found in acid urine, the bladder is seen to be clear, but pus is coming from one ureter, the mouth of which is swollen and inflamed. The urine contains tubercle bacilli.

The diagnosis is from chronic posterior urethritis and *Bacillus coli* infections of the urinary tract.

The prognosis is excellent and the treatment nephrectomy.

2. *The "straightforward" type.*—Complaint is of aching pain in loin and bladder, pyuria, increased frequency of micturition. Examination reveals a large tender kidney, an infected bladder, nodules in the ureter, vesiculæ, prostate, or testicles.

The prognosis is poor, and the treatment includes attention to the general health, tuberculin, sandal oil, and rarely nephrectomy in selected cases.

3. *The "pyonephrosis" type.*—The complaint is of aching pain in one loin of a few weeks' or months' duration, and a feeling of weight, and discovery of a belly tumour, but no pyuria, and no increased frequency of micturition. Examination reveals a gigantic pyonephrosis, obsolete.

The diagnosis is from other abdominal tumours.

The prognosis is fair, and treatment, nephrotomy followed by nephrectomy at a second operation.

4. *The "hæmaturia" type.*—The complaint is "sudden and profuse hæmaturia." Examination shows blood from one kidney or possibly both (congestion), giving way to pus and tubercle bacilli from one kidney. This leads to exploratory operation and nephrectomy.

The diagnosis is from neoplasm and granular kidney.

5. "*Latent" type.*—There are no signs or symptoms at all, the disease being found at autopsy.

Prognosis.

As Albarran writes: "*Tuberculosis of the kidney is a one-sided local disease with progressive march, ending in complete destruction of the kidney.*" This process of natural and spontaneous nephrectomy may take from six months to ten years, but on an average it takes eighteen months to three years, and in the meantime the diseased kidney remains as a constant source of infection both for the lower urinary tract and for the rest of the body. Without nephrectomy the course is inevitably downwards to a fatal issue, with comparatively long periods of immunity from all symptoms. On the other hand, if the diseased kidney be removed early, while it still remains the only tuberculous focus, the prognosis for absolute cure is excellent, and relief can always be expected. Albarran followed up seventy-seven of his cases; fifty were cured, seventeen relieved, and only ten had died, five of tuberculosis of the lungs. Even when the ureter and bladder have become infected, removal of the kidney will often give these a chance

to heal, and cure or many years of latency may ensue. If secondary deposits are very extensive nephrectomy may be justified, and sometimes seems to delay the downward course of the patient. Apart from nephrectomy in the early stages these cases yield inevitably to death from cachexia, septicæmia, or uræmia.

Treatment.

Modern treatment is based on the following well-ascertained facts:

1. Tuberculosis of the kidney is a unilateral local disease in 80 to 90 per cent. of the early cases.
2. In 90 to 95 per cent. of the cases it is a hæmotogenous and descending infection (sixty-one cases out of sixty-two, Kapsammer, 1907).
3. Pus and tubercle bacilli in the urine are the only specific signs of the disease.
4. The site of the disease, and the functional value of each kidney can be determined by ureteric catheterisation.
5. Early diagnosis leading to excision of the kidney which contains the primary focus holds out good prospect of cure in an increasing number of cases.
6. Spontaneous cure is unknown. When once the disease has started in the kidney it leads sooner or later inevitably to complete destruction of the kidney if the patient does not succumb before that has happened.
7. If left to itself the disease is fatal.

Spontaneous Cure is Unknown.

Most modern authorities now accept this view without hesitation, which is based on a large mass of observations made in the last ten years, including such names as Albarran, Hartmann, Tuffier, Legueu, Carlier, Delbet, Casper, Israel, Kapsammer, Kelly, Keyes, Tilden Brown, but a few, such as Le Fur and Godlee, still remain opposed to it. The disease may become latent for a time, especially when the ureter is blocked, and pus is no longer passed with the urine. Superficial observation at this stage would declare that the disease was cured; but it is now known that the disease goes on though the ureter is blocked, and often for a long time without pain or cachexia, leading to complete destruction of the kidney and the formation of a bag of fibrous tissue containing pus.

Indications for Nephrectomy.

A. *One-sided disease of the kidney and ureter* if the opposite kidney is able to carry on the functions of both.

1. *The kidney being the sole lesion.*

2. *With early infection of the bladder as well* (which heals after nephrectomy).

3. *With early infection of the bladder and disease of one testicle* (combined with orchidectomy).

4. *With tuberculous foci in other organs,* if these are inclined to heal, as removal of one focus often turns the scales in favour of the body against another focus.

B. *Both kidneys affected,* one an obsolete pyonephrosis, the other hypertrophied and but slightly affected. The removal of the pyonephrosis may prolong life for four or five years at least.

Contra-indications.

A. When the other kidney is severely affected or is not equal to carry on the complete renal function.

B. When persistent pyrexia and wasting combined with extensive scattered foci elsewhere show that the patient has but a few months to live and should not be submitted to a useless operation.

Immediate mortality.—In 1894 Vignerow's figures gave nearly 40 per cent. mortality for this operation. In 1904 Casper's figures were 12 per cent. In 1908 Albarran published a series of 108 consecutive cases with mortality of three, one from hæmatemesis, one from meningitis, and the other because no second kidney was present. The average results of the last few years show a mortality of 6 to 12 per cent. In the future the mortality should not be much more than 2 per cent. if the diagnosis is made early and if the ureteric catheters are used in every case.

Remote results.—Albarran followed up 77 of his 108 cases: 50 were cured, 22 seen two years, 14 six years, 3 nine years after the operation; 17 still had vesical trouble, but were much better for the operation; 10 died later, 5 from tuberculosis of the lungs.

Technique.

Certain points must be observed if it is desired to remove the whole of the disease without infecting the wound and the peritoneum, or leaving a fistula.

1. The kidney should not be incised to confirm the diagnosis, as this should be certain before the operation.

2. The peritoneum should not be opened, as it may become infected should an abscess burst and soil the wound; in other words, the lumbar route is *always* employed.

3. The fatty capsule, if infected, should be removed.

4. Stout catgut should be used for ligatures, as silk is a potent cause of persistent sinus (Albarran).

5. The ureter should be followed down to the brim of the pelvis and excised at this point, the lumen being cauterised, and catgut used for ligature.

Nephrostomy or *nephrotresis*, that is to say, permanent drainage of the kidney, is the beginning of the end, and should be abandoned, just as surgeons have abandoned drainage of tuberculous abscesses elsewhere in favour of incision, emptying, scraping, and immediate complete closure without drainage. Secondary infection is the inevitable result of nephrostomy and hastens the approach of death.

Only under two conditions can nephrostomy ever be sanctioned, and then only as a temporary measure for ten days or a fortnight.

1. To drain a large pyonephrosis so as to reduce its size and enable lumbar nephrectomy to be performed at a second operation.

2. When the state of the bladder renders ureteric catheterisation an impossibility to enable the urine to be collected and separated from that of the opposite kidney.

Partial nephrectomy as a formal operation has been abandoned, as it is found impossible in practice to be sure that a small focus of disease has not been left behind which will progress and destroy the rest of the kidney. If cure is desired complete nephrectomy is the only certain method.

Nephrotomy may be performed, abscesses opened and scraped, and the kidney and parietal wound *completely* stitched up again if one kidney has already been removed and an abscess forms in the opposite loin which appears likely to burst and set up secondary infection and fistula.

Summary.

Tuberculosis of the kidney is a unilateral primary hæmatogenous infection, is common, and leads to infection of the rest of the urinary tract and ultimate body-death. Spontaneous cure is unknown. Certain cure can be effected by early diagnosis and early nephrectomy.

CHAPTER IX.

RENAL SYPHILIS.

SYPHILIS may attack the kidney in the following manners:

1. Early in the "secondary" stage at the time of the skin eruption as a transient albuminuria.
2. Later in the "intermediary" stage as an acute nephritis, which may resolve or lead to chronic parenchymatous and interstitial nephritis.
3. In the "tertiary" stage as an interstitial nephritis, localised or diffuse, with or without gummata (necrosis) and amyloid change.

In other words the *Spirochæta pallida* circulates in the blood and may produce any form of toxic nephritis or degeneration of the kidney, the only specific changes being seen in the last group when gummata, amyloid change, and syphilitic arteritis are in evidence.

In the first two groups the changes do not differ from those of toxic nephritis in general.

The latter group is of surgical interest, as it may simulate renal neoplasm and tuberculosis, but is not at all common. The perinephric tissue is dense and sclerosed, the capsule is thickened and strips with difficulty, tearing the surface of the kidney; the kidney is tough, very much enlarged, irregular and scarred. On section the tubules are degenerated and obscured by the presence of dense bands of interstitial fibrous tissue. The fibrous tissue may be scattered diffusely throughout the organ or be confined to a portion only. Areas of necrosis may be seen (gummata), irregular yellow areas which cut like cheese, surrounded by a bright red ring of blood-vessels, outside which, again, is a wall of dense fibrillar tissue. Rarely these solid, cheesy areas liquefy and form fluid resembling pus. Amyloid change can be demonstrated by employing suitable chemical reagents.

There is a large diffuse form which simulates a sarcoma, and a caseating form which suggests tuberculosis. The presence of a vascular red ring round the margin of the yellow gummatous mass, though not pathognomonic, is highly suggestive of tertiary syphilis.

Microscopically the cells of the tubules show atrophy ar degeneration, the interstitial fibrillar tissue is much increase and amyloid changes can be demonstrated in the walls of tl blood-vessels and the basement membrane of the tubule while the blood-vessels show well-marked syphilitic me arteritis and endarteritis. The gummata show a central, no: staining, granular mass surrounded by a young, highly vascul: granulation tissue and outside this a denser ring of wel formed fibrillar tissue.

Clinically during the early secondary stage of syphili transient albuminuria may appear in 8 to 12 per cent. of tl cases (Harrison, Fürbringer), quite apart from the exhibitic of mercury. Later in the disease typical attacks of acu nephritis may occur, either clearing up entirely or going on the chronic forms, but how far these are specific and how f due to other kidney poisons, such as mercury, acting on person who has syphilis is hard to say. The disease ma likewise manifest itself, especially in the congenital cases, a diffuse amyloid condition of all the viscera, especially tl liver, spleen, and kidneys, with or without gummata, wi chronic jaundice and ascites, and the various stigmata of tl disease.

Another form which comes under the more immediate noti of the surgeon and is very likely to lead to wrong diagnos and treatment, is seen when the disease attacks chiefly o kidney alone, giving rise to a *large renal tumour* made up of diffuse fibrous mass, renal and peri-renal. A large, painle tumour of the kidney appears, of slow growth, hard, and fix to the surrounding parts; the urine remains clear, or may co tain a trace of albumen; attacks of hæmaturia may occu caused by the high general blood-pressure, but pyuria is almo unknown; the opposite kidney may be healthy, or enlarg from hypertrophy or fibrosis, or may be shrivelled and functio less. There may be no general symptoms, or the early an late manifestations of chronic interstitial nephritis may appea and there may be no other outward or inward signs of syphil to be detected except after a prolonged and thorough searc Very rarely a softened gumma bursts into the ureter or on the skin.

The diagnosis is extremely difficult and is not often mad until microscopic examination after nephrectomy.

Clinically the absence of pus-cells and tubercle bacilli i the urine are sufficient to make the diagnosis from tuberc losis.

The slow, painless growth of a hard tumour, with attacks of hæmaturia, and even the presence of varicocele (Legrains), simulate very closely a malignant neoplasm, so that in considering the diagnosis of neoplasm syphilis should always be excluded, even though it is thought to be rare. An authentic syphilitic history, the presence of syphilitic lesions in other parts of the body, and the effects of anti-syphilitic treatment may suffice for a diagnosis; but more often the diagnosis is only made after an operation by naked eye and microscopic examination of the tumour.

In syphilitic lesions of the kidney a nice question arises as to whether mercury should be exhibited. The practitioner feels that the mercury may be the cause of the albuminuria, or if not the cause, that it may not be properly eliminated by the damaged kidneys and lead to poisonous symptoms; and yet, if the disease be caused by the syphilis itself, mercury should be curative. The best plan undoubtedly is to exhibit mercury with caution in steady, small doses by the mouth, watching its effects, toxic and otherwise, daily, and not employing such methods as inunction and injection when the dose once given cannot be controlled or recalled. Unless beneficial effects are observed, the dosing can be stopped for a time and the patient treated on general lines. In the later stages the iodides should be pushed as they will benefit the general vascular condition, even though it be too late to save the kidney.

CHAPTER X.

PRIMARY NEW GROWTHS OF THE KIDNEY, ITS PELVIS AND ITS CAPSULE.

Predisposing Causes.

A. Embryonic Rests.—Embryonic rests are formed by the encapsulation of a small collection of the embryonic cells of a developing organ, either in the organ itself or in an adjacent organ. The cells may remain embryonic or develop into adult cells.

The urogenital apparatus is rich in embryonic rests of various kinds, and by far the greater number of renal growths undoubtedly arise in such rests (65 to 75 per cent. of all renal tumours, Küster), though why the quiescent rest should at a given moment become "malignant" is unknown.

Since the paper of Grawitz, in 1883, rests of typical and atypical adrenal cortical tissue are well recognised as common, not only in the adrenal itself but also in the kidney, perinephric tissues, ureter and other organs. A tumour thought to arise in these is called "hypernephroma" or "epinephroma."

Rests of the primitive myotomes give rise to pure rhabdomyoma or tumour of embryonic striped muscle.

Germinal epithelium rests are common in children, and give rise to the mixed embryoma or teratoma.

B. Chronic Irritation.—Renal calculus and chronic pyelitis are predisposing causes of malignant papilloma or epithelioma of the renal pelvis.

C. Age.—The majority of renal growths appear at two periods of life: first, between the age of one and five years (45 per cent.); secondly, after thirty-five to forty (45 per cent.).

Sex has no influence, nor has heredity nor race. Either side is about equally affected and either pole, though it used to be held on Rovsing's authority that the upper pole is the more common site.

Pathology.

It is impossible to classify renal growths on an embryological basis, as embryologists are not agreed as to the origin of the cells of the renal pelvis, the secreting tubules, and the cells of the adrenal cortex. In all probability the cells of the renal pelvis and collecting tubules are ectodermal in origin, and therefore carcinoma can be applied to tumours that arise from them. Neoplasms of the secreting cells, being probably mesothelial in origin, should strictly be termed "endotheliomata" (cœlomic type), or strictly "endothelial sarcomata" (see Ch. II).

Benign tumours of the kidney are met with in the post-mortem room with great frequency, but they rarely become large enough to be manifest clinically. They include adenoma, papillo-cysto-adenoma, fibroma, lipoma, myoma, chondroma, osteoma.

Neoplasms can be divided into three groups according as they grow from (*a*) the parenchyma, (*b*) the pelvis, and (*c*) the capsule.

A. Of Parenchyma.

1. *Hypernephrema* (type of Grawitz), *v.* p. 198.

Golden tumours, generally encapsulated, showing fat in the cells. They vary in malignancy, may slumber for years, and are common in adults.

2. *Gland-like Tumours* ("*Adeno-carcinomata*").

These show lumina lined by cells, columnar or cubical, resembling those of the renal collecting tubules; they contain no fat, but may show cysts and papillary intra-cystic formations but no glomeruli. They are rare, rapid of growth, very malignant, and spread by lymphatics.

3. *Tumours Formed by Cells Resembling Embryonic Connective Tissue* ("*Sarcoma*")

These are round, spindle, mixed, or giant-celled, are rare, very malignant, and spread by blood-vessels.

4. "*Mixed Tumour*," "*Embryoma*," "*Teratoma*."

These occur chiefly in children, may show any embryonic structure, take origin in germinal epithelium, may be bilateral;

enormous local growth is the rule, and metastases are uncommon.

B. Of Renal Pelvis.

(1) *Villous papilloma.*
(2) *Epitheliomatous ulcer.*

The cells resemble pelvic cells, and cell-nests are seen. They are rare, of slow growth, destroy the kidney locally, invade the lymphatics, and spread down the ureter into the bladder in the stream of urine.

C. Of Fibrous and Fatty Capsule.

Sarcomata—round—spindle—giant—fat—muscle—cartilage—bone-cells,—vary in malignancy,—are often classed with retro-peritoneal sarcomata.

Morbid Anatomy.

A. Neoplasms of Parenchyma.

A portion of the kidney appears to be expended into a tumour with smooth, bossed surface, which may be very hard and solid, or more often is soft and definitely fluctuant. On section the cut surface reveals a tumour mass usually sharply marked off from the rest of the kidney by a clearly defined *capsule.* The kidney substance is pushed aside and expanded over the tumour rather than destroyed. Trabeculæ of fibrous tissue are seen surrounding clearer areas of tumour cells. The *colour* may be white, bluish grey, but in cases of typical hypernephroma is a golden brown, due to the presence of "fat" in the cells. Areas of hæmorrhage, necrosis, and cyst-formation abound.

Microscopic examination commonly reveals one of three types: 1. Hypernephroma; 2. Adeno-carcinoma; 3. Sarcoma.

1. *The Hypernephroma Type.*

A delicate stroma formed by connective-tissue cells and containing large capillary blood-spaces forms a sponge work, the meshes of which are filled by endothelial cells resembling in differing degrees in different tumours the cortical cells of the adrenal bodies, large polygonal cells with vacuolated protoplasm, the vacuoles containing droplets of "fat" ("protagon" Stoerck) and glycogen (Lubarsch) and brown

pigment. The nucleus is circular, distinctly stained, and shows a definite chromatin network.

Necrosis of the central cellular areas is common, and gives rise to the appearance of false lumina filled with granular *debris*. Hæmorrhage occurs into these lumina, which then appear like blood-vessel endotheliomata and peritheliomata, and are reported as such in the literature, but Ribbert flatly opposes the nomenclature.

In typical cases the histological recognition of this group is easy, especially *if fat* droplets be present in the cells, a condition found in no other common renal tumour.

The *presence of fat* is characteristic (Börst and Ribbert), as is also the peculiar *golden-brown colour* of the fresh tumour on gross section.[1] Stoerck, in a recent paper, throws doubt on these views, and endeavours to prove that these tumours have nothing to do with the supra-renal at all but are all renal, adenomata, or carcinomata.

2. *Neoplasms of Glandular Epithelium* (*"Adeno-Carcinomata"*).

(*a*) From collecting tubules, "carcinomata."

(*b*) From secreting tubules, "endotheliomata."

A delicate vascular connective-tissue stroma contains closed canal-like spaces lined by a single layer of cells. These cells are columnar, cubical, or even flattened out in the more cystic parts. The protoplasm is clear and contains no fat. The nuclei are ovoid and clearly stained and lie towards the basement membrane. In places the cells may lie in several layers and may even fill the lumina. The lumina may be empty or may contain blood and the products of necrosis. The spaces are often distended with cysts, and may contain papillated processes in their walls lined by epithelium.

Cells more or less resembling those lining the tubules are seen lying in the lymph-spaces around and infiltrating the interstitial tissue and lymph-channels of the kidney substance. No glomeruli are ever found.

3. *Neoplasms of Interstitial Tissue Cell Type* (*Mesenchyme Type*), *"Sarcoma."*

These may consist of masses of round cells or of spindle cells, or of both, with a very sparse supporting network and

[1] For this reason they were often dismissed as lipomata before the paper of Grawitz, 1883.

numerous blood-spaces, the walls of which are often formed by the cells of the growth; giant-cells are common, and a fibrous capsule is well marked at the boundaries of the tumour.

4. *Mixed Tumours; Embryoma; Teratoma.*

There is a connective-tissue basis to the tumour, condensed into well-marked bands which split the tumour up into loculi. In this tissue may be seen any kind of embryonic connective tissue. Tubules or spaces lined by epithelioid cells are common. Some of these may be renal and glandular, others are definitely primitive neuronic ectodermal tubes such as occur in gliomata (Ribbert). Squamous cells and horn are occasionally seen. *Embryonic* forms of striped muscular fibres are common, arranged in bundles as long spindle cells with a central core of clear sarcoplasm containing nuclei, and an outer layer of striped ectoplasm. They contain droplets of fat and glycogen. In the less malignant varieties, fat, cartilage, and even bone may be found. In the more malignant the cells are mostly of embryonic type, round, spindle, and giant. These tumours undoubtedly arise from portions of germinal epithelium sequestrated in the kidney substance. They have usually a well-marked capsule, and push the kidney aside rather than infiltrate it. They grow to enormous size and only occasionally give rise to metastases.

B. Papilloma.

This may arise in a patch of ulceration caused by a stone. In the early stages it forms a localised or diffuse papillomatous mass which tends to spread over the whole surface of the pelvis and calices. The ureter is blocked either by a previously existing stone, or by the spread of the papillomata into the ureter; the pelvis and kidney are hollowed out and dilated to form a small hydronephrotic sac. The growth invades the renal tissues and destroys them, and ulceration occurs, so that the kidney is turned into a hard, fibrous shell, the hollow of which is lined by a papilliferous malignant ulcer.

Microscopically the papillomatous processes resemble those of the bladder (see Ch. VI, Sect. III). The kidney substance beneath shows great increase in the interstitial connective tissue, accompanied by destruction or atrophy of the tubules.

The interstitial tissue spaces and the lymphatics are infiltrated with polyhedral epithelioid cells, and in places peculiar cell nests are formed, exactly resembling those found in the rare carcinomata of the ureter and urethra. The cells penetrate to the capsular lymphatics, causing fibrosis and consequently fixity in this tissue, and also to the juxta-aortic glands.

c. Neoplasms of the Fibrous and Fatty Capsule.

Benign tumours of simple tissue types may rarely occur, and lipomata sometimes assume a large size and become noticeable clinically. Round, spindle and mixed - celled sarcoma arise and are sometimes classed with the retroperitoneal sarcomata. Embryonic rest tumours may occur as "Pararenal Tumours" either adrenal, or mixed, *i.e.* of the hypernephroma or embryoma type.

Morbid Physiology.

A very large percentage of these neoplasms, in their early stages at least, do not seem to produce any toxic body which, escaping into the blood, might affect the other cells of the body, but in the later stages such bodies undoubtedly exist and produce wasting, anæmia, cachexia, and even a daily rise of temperature to 102° or 103° F., quite apart from any secondary infection with organisms (the febrile or toxic type); and sometimes gastritis, colitis, nephritis[1] and so forth. At the same time the minority do so from the first, and the majority of the others sooner or later.

Local Functional Disturbance.

1. *The affected kidney* may continue for a long time to secrete a normal urine or it may very shortly be depressed in function, oliguria or polyuria being noted, with possibly a trace of albumen and diminution of pigment and salts.

[1] A secondary nephritis occurs in the opposite kidney and may become very severe. This has been shown to disappear after removal of the neoplastic kidney (Kapsammer, Albarran). It is similar to that found in cases of tuberculosis of one kidney (Albarran), that is to say, the urine from the sound kidney (taken by ureteric catheterisation) is found to contain a trace of albumen, casts, and even blood, the specific gravity may be much diminished, there may be obliguria or polyuria, and the functional tests may show diminished function; yet after removal of the neoplasm all these bad signs may disappear and the remaining kidney prove quite equal to its task of excretion and metabolism. Another suggestive fact is that the opposite kidney seldom, if ever, shows any attempt at hypertrophy until after the removal of the diseased kidney.

2. The blood-vessels, especially the veins of the affected kidney, and, in fact, of the whole upper urinary tract of the affected side, may show great hypertrophy. Tortuous or distended veins (like blue earth-worms) may be seen surrounding the kidney capsule, in the hilum, along the ureter, and cystoscopically in the veins running to the ureter's mouth along the edge of the trigone (Fenwick), as well as in the pampiniform plexus (varicocele).

Pathology of Spread.

The majority of renal growths are at first distinctly encapsuled, but sooner or later the cells burst through this capsule and invade the surrounding connective-tissue spaces both of the kidney and its capsule, and of surrounding structures such as the peritoneum, adrenal, and the wall of the ureter. From these spaces the cells may enter the lymphatics, but this seldom occurs except in the case of the adeno-carcinomata and the epitheliomata of the renal pelvis. These lymphatics run along with the veins in the hilum of the kidney to end widely in the glands of the juxta-aortic chain, from the lowest at the promontory to the very highest round the aortic opening in the diaphragm, from which they pass both into the receptaculum chyli and into the posterior mediastinal glands. When the lymphatics become blocked with cells the flow in them may be reversed, and cells may pass back into the spaces of the fatty capsule. More often the tumour breaks into a large renal vein, and extends as a long snake-like process into the vena cava, and even into the right auricle of the heart. Malignant emboli split off from this focus, and appear in the lungs, liver, opposite kidney and many other organs, and *notably in the bones.* Secondary bone nodules of large dimensions which form large pulsating tumours are by no means rare, and may be the first symptom of the diseased condition, which is especially true of hypernephroma. The growths burst into the pelvis or ureter, and give rise to hæmaturia, and less commonly they give rise to implantation deposits on the wall of the ureter and bladder.

Clinical Symptoms and Signs.

Golden Rule: *All neoplasms that can be recognised clinically, are to be considered as malignant, and treated as such.*[1]

[1] Rare exceptions: cavernous angioma of renal pelvis, lipoma of fatty capsule.

All new growths pass through three stages, a latent stage, an operable stage, and an inoperable stage.

The onset symptom differs somewhat in adults and in children; in adults it is "painless hæmaturia," in children it is "painless renal tumour."

Life-History of Renal Neoplasm.

1. Latent Stage.—No symptoms or signs are in evidence to point to disease, but a renal tumour may be discovered accidentally by the patient or during a routine abdominal palpation. Many cases are on record to show that this latent stage may be of remarkably long duration, even of many years. In a case of Billroth's, quoted by v. Eiselsberg, a hypernephroma was removed from a patient who remained well for ten years but then sickened and died of mediastinal growth, which proved to be malignant deposits of hypernephroma in the bronchial glands. This must be remembered both in urging nephrectomy and in debating the question of cure.

2. Operable Stage.—Onset symptoms are either hæmaturia or renal pain.

Hæmaturia.—In a large majority of the cases this is the onset symptom. It comes on suddenly, spontaneously, without any previous warning, and is due to rupture of the capsule into the renal pelvis. It is generally bright, often profuse, and symptomatically it may last for a day or several days, when it again stops suddenly. The patient may lay stress on some slight blow on the side. The slight nature of the injury and the brightness of the bleeding should warn the practitioner that he has to deal with something more than a ruptured kidney. If the hæmaturia is very profuse ureteric "clot-colic" ensues, that is to say, the blood clots in the renal pelvis and is then squeezed down the ureter by forcible peristalsis, which is painful. The pain itself differs in no way from that of colic caused by the passage of a stone.

The characteristic features in the case of growth are that the bleeding precedes the pain, whereas in the case of stone pain precedes the bleeding. The presence of worm-like clots in the urine may occur in either, being merely blood-clots moulded by the ureter. The bleeding is caused by the rupture of a vessel of the tumour through its capsule into the renal pelvis, and is a sure sign of malignancy waking from the latent stage of slumber. Other changes in the urine are uncommon at this stage.

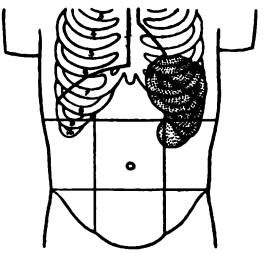
Frequency of micturition is, as a rule, unaltered, but exceptionally it is much increased.

Pain is seldom a marked feature in adults.

"Clot colic" or typical renal colic, caused by the passage of clots along the ureter, is that most usually experienced. A dull aching pain in the lumbar region comes on when the tumour attains a large size. Last of all pains due to the involvement of nerve-trunks may appear, but they are evidence that the last or inoperable stage has been reached.

Physical Examination.

A renal tumour may be discovered on abdominal palpation, but it is surprising how often it cannot be felt, especially on the left side. It may be felt more often under general anæsthesia. Many neoplasms take origin at the upper pole,



and grow upwards under shelter of the diaphragm, where they are hard to feel except during full expiration, though upper pole tumours are not more common than lower pole, as was once held (Rovsing, etc.).

For the general character of the tumour, and for the differential diagnosis from other abdominal swellings, see Ch. IV, VI.

Varicocele.—It is undoubtedly an important and helpful sign in diagnosing renal growth when a varicocele appears suddenly and spontaneously in an adult over thirty years of age on the *right* side.

This enlargement of veins is definitely not due to the presence of enlarged glands at the hilum, as Hauser stated, for it occurs quite early and in cases where the glands are not affected. Nor does it seem likely that it is due to the pressure of the enlarged kidney upon veins, as it does not seem to occur in the case of other enlargements of the kidney (tuberculosis, hydronephrosis). It appears to be a manifestation of the general increase in the vascular supply of an area

affected by malignant growth, as emphasised by Goldmann for neoplasms in general, and it disappears if the neoplasm is completely removed (Henry Morris). It is not necessarily a sign of a blocked vena cava or of an inoperable tumour as some authorities state.

Cystoscopic examination.—This should be carried out if possible before the bleeding stops or a golden opportunity will be lost of determining the kidney affected, as urine tinged with blood can then be seen issuing from one ureter (resembling a volcano in eruption), whereas the efflux from the other ureter is clear. In this way all causes of bilateral renal hæmaturia are at once excluded. An enlarged venous trunk around and entering the mouth of the ureter is highly suggestive of neoplasm, especially if accompanied by varicocele and renal tumour on the same side.

Ureteric catheters should be passed and the urine from each side carefully examined in the routine way (see Ch. I). One special difficulty is that the function of the non-affected kidney may be depressed by toxins or reflexly from the affected kidney (see above, "Morbid Physiology"), and it may be fitter to carry on its task than it may appear before excision of the tumour.

Röntgen rays.—Radiographs should always be taken.

Urine.—Apart from blood, other changes are not common.

The blood is intimately mixed with the urine and varies in colour from bright arterial red to a dull smoky brown. Worm-like casts of the ureter are seen towards the end when the bleeding has nearly stopped.

Albumen is uncommon apart from the blood, but it may be present as a sign of toxic nephritis in the substance of both kidneys induced by the products of the cells of the neoplasm. The specific gravity may be unaffected, raised or lowered. The amount of urine is often unaffected, but there may be either marked oliguria or polyuria at different periods of the same case history. Pus only appears in late secondary infections of the diseased kidney.

3. Inoperable Stage.—The growth becomes fixed to the surrounding parts by dense fibrous adhesions, which engulf dead and living cells of the invading neoplasm. Fixity is the sure sign that this stage has been reached. Signs of pressure on nerves, blood-vessels, lymphatics, bones, viscera, grow increasingly evident. Œdema of one or both legs, jaundice, ascites, tell their own tale, and the presence of anæmia,

cachexia, wasting and sporadic vomiting warn of the approaching end. Secondary nodules spring up in mediastinal and cervical glands, in the lungs and liver, and large pulsating bone-tumours make their appearance.

Death ensues, usually from exhaustion and heart failure, uræmia and suppression of urine, or even a profuse hæmorrhage from some portion of the growth.

Life-History in Children.

The onset symptom in children is a *renal tumour*. *Hæmaturia* is not common.

The tumour may attain an enormous size (forty pounds or more) and weigh almost as much as the rest of the child. It leads commonly to pressure - symptoms and kills by exhaustion. Pain is uncommon; varicocele has not been noted. The urine seldom shows any signs that are of help.

The diagnosis of the nature of the renal tumour must be made from other causes of renal enlargement in children, such as hydronephrosis due to congenital stricture of the ureter and congenital polycystic disease of both kidneys.

Diagnosis.

In cases of *painless hæmaturia* without obvious tumour the diagnosis is made by complete clinical examination and by exclusion (*cf.* table, Pt. I).

In cases of "*tumour*" the diagnosis has to be made from other abdominal swellings and from other renal swellings (see pages 61, 62, 119).

Remember—(*a*) renal growths are not common.

The diagnosis should, then, be made with reluctance. On the other hand it is well to remember that "painless hæmaturia" should at once suggest neoplasm of bladder or kidney.

(*b*) *Painless hæmaturia* is *the* sign of a tumour that gives hope of early nephrectomy and a cure.

(*c*) *Painful fixed tumour* means late inoperable growth.

(*d*) In many cases we may strongly suspect neoplasm, but the suspicion can only be confirmed by exploration of the kidney.

(*e*) No surgeon should operate till he has evidence that the blood issues from one side only.

POINTS IN DIFFERENTIAL DIAGNOSIS OF THE VARIETIES OF RENAL NEOPLASM.

This can only be made for certain by histological examination of each tumour after its removal.

In children most of the tumours are embryonic mixed growths, though rarely the other forms occur at this age. In adults hypernephroma is far the most likely to appear (65 to 75 per cent.), especially if the tumour has shown a tendency to latency or to resting stages in its growth, and if it is large, yet freely movable. Small, fixed neoplasms of rapid growth are less common, but are likely to be "adeno-carcinoma" or "epithelioma of renal pelvis." Large, bossy growths of rapid continuous growth and early metastases may be "sarcomata."

Prognosis.

Without operation the disease is inevitably fatal.

Fixity of the growth or the obvious presence of secondary deposits and advanced cachexia preclude operation. If the growth is still mobile, if the general condition still remains good, and especially if the diagnosis has been made early after the first attack of hæmaturia, *then operation holds out a fair chance of cure.* For instance Rovsing reports fifty cases with eighteen complete cures, eight having been watched for from five to sixteen years since the operation. The dangers and difficulties of the operation diminish with early diagnosis, and the early removal of a small tumour just awakening into malignancy from its stage of slumber, as expressed by a slight hæmaturia, is followed in an increasing number of cases by absolute immunity from further trouble. This can be especially emphasised to the patient when the microscope shows that the growth removed is a typical "hypernephroma." More caution is needed when this shows the presence of a "sarcoma" or an "adeno-carcinoma."

In children the chief dangers to be apprehended are those of the shock of the operation itself, and the fact that one kidney may be absent, or the victim of another independent tumour.

If the child survives the operation the chance of recurrence and secondary deposit is not a great one, as many of the embryomata do not give rise to metastases even though they have attained gigantic proportions.

The use of spinal anæsthesia for these cases should

diminish considerably the shock of the operation and consequent death.

Treatment.

Total nephrectomy is the only measure that holds out a hope of cure. Partial nephrectomy or enucleation have proved worthless. Total nephrectomy includes an attempt to remove the whole peri-renal fatty capsule, with the cellulo-fatty tissue of the hilum, the lymphatic glands both around the hilum, up and down the same side of the aorta as far as the promontory and openings in the diaphragm. If it is possible the adrenal of the same side should be included in the mass of tissue removed (Gregoire).

Before deciding on operation, a determined effort must be made to ascertain the functional value of the other kidney, and its presence may occasionally be determined by the Röntgen rays.

Many authors advise exploration of the other kidney first, to be sure of its presence, though *nothing* can be told with regard to its functional value by this means, and in one case v. Eiselsberg thought he felt the kidney, which proved at the autopsy to be absent altogether.

By means of ureteric catheterisation and examination of the urine and blood (see Ch. I) the functional power of each kidney is determined, and until this has been done it is not justifiable to remove the affected kidney.

CHAPTER XI.

CYSTS OF THE KIDNEY.

1. *Retention cysts.*
2. *Polycystic kidney.*
3. *Simple cysts.*
4. *Cystic degeneration of neoplasms.*
5. *Hydatid cysts.*
6. *Dermoid cysts.*
7. *Paranephric cysts.*

1. Retention Cysts.

Single or multiple thin-walled cysts are found at autopsy in specimens of granular kidney. They vary in size from a pin's head to a cherry, and contain clear fluid or colloid material. The interstitial fibrosis obliterates the lumen of certain tubules, which become distended and cyst-like. Such cysts are of no surgical importance and should not be confounded with the next variety.

2. Polycystic Kidney.

PATHOLOGICAL ANATOMY.

Naked-eye description.—For practical purposes the disease is found to be bilateral, though it is often more advanced on one side than the other, but rare cases have been reported where the disease has been unilateral. The kidney retains its general outline, but is seen to be packed with thin-walled cysts of a size varying from a pin's head to that of a Tangerine orange. The cysts contain fluid, which may be clear, pale, straw-coloured, or blood-stained, may be turbid or brown, or may be colloid, and the cysts are scattered irregularly throughout the organ and project beneath the capsule. Portions of normal cortical and medullary tissue may be evident between them.

In the later stages a generalised interstitial fibrosis always appears, and other secondary changes may be seen, such as

points of suppuration, generalised pyelo-nephritis, and, indeed, any other disease to which the healthy kidneys are liable, such as stone, hydronephrosis, neoplasm, and so forth. The organ is sometimes unduly mobile and may present a kinked ureter with secondary hydronephrosis.

Histology.

The cyst-walls are formed by a delicate basement membrane, on which lie epithelial cells, which may be flattened, cubical, or columnar, and give rise to intra-cystic projections. The contents of the cyst may be colloid, or contain epithelial cells, blood-corpuscles, leucocytes, and crystals of uric acid, oxalates, phosphates, and cholesterin. The renal tubules in the neighbourhood of the cysts are healthy in the earlier stages, but eventually an interstitial fibrosis is set up in the neighbourhood of the cysts and throughout the whole organ, and at the same time the cells of the tubules undergo atrophy or degeneration, and all the changes of granular kidney are super-imposed. Secondary suppuration and hydronephrosis lead to their respective characteristic pictures. One case is described where the interstitial tissue became sarcomatous.

Morbid Physiology.

The cystic fluid may contain urea, albumen, uric acid, calcium oxalate, and phosphate crystals; colloid and cholesterin and altered blood and pus are present as secondary changes. The kidneys may be capable of secreting a normal urine, or one sufficient for the needs of the body, even though it may be hard to demonstrate with the microscope any healthy renal substance. Some of the persons affected die of old age or of intercurrent disease, but the majority tend to develop a condition of fibrotic kidney and perish of uræmia.

Changes in Other Organs.

The other organs may be healthy, but when a secondary fibrosis has occurred the cardio-vascular and other changes associated with granular kidney are found. Other congenital malformations of the rest of the urogenital tract and of the body as a whole are extremely common in children but rare in adults, the explanation being that the severer cases come under notice in early life, whereas the slight cases remain latent till middle age. Polycystic disease of other organs is

often found, especially in the liver, and of the sixty-three cases collected by Lejars seventeen possessed cystic livers. Less commonly the disease is seen in the spleen, ovaries, testicles, ureters, uterus, bladder and thyroid.

Ætiological Factors.

The disease may appear in several generations and may affect some or all of the members of a family. Isolated cases occur in families who show a tendency to congenital malformations of other organs, and the disease is often combined in the same individual with congenital deformities, facts which strongly suggest that the disease is to be looked upon as a germinal mutation or sport. Complete family records are needed in this connection.

Clinically the disease is noticed chiefly at two periods of life—in infancy and in middle life—but cases occur at any age, facts which do not in any way exclude a germinal origin for the adult cases, as germinal changes may be delayed in their full development till any age. The disease is far commoner in females than in males and is nearly always bilateral. Seiber, out of 149 cases, found nine unilateral, six on the left side, three on the right.

Pathogenesis.

Summary of the Various Hypotheses.

A. *Those which invoke a* GERMINAL *origin.*

1. That there is a failure to unite on the part of the primitive buds of the collecting tubules with the blind tubules of the primitive metanephros (see Ch. II).

2 That the cysts represent remnants of the mesonephric tubules entangled in the metanephric anlage.

3. That there is a congenital feebleness of the walls of the kidney tubules, which are unable to withstand the intratubular urinary pressure.

4. That the disease is a form of benign neoplasm or of multiple cysto-adenomata, having an embryonic origin.

B. *Those which invoke an* ACQUIRED *cause working on a healthy kidney blastema.*

1. That the primary change in adults is a process of interstitial fibrosis, and that the cysts are multiple retention cysts.

2. That the cysts arise in a fibrotic kidney as an endeavour to form fresh tubules—cysto-adenomata of hypertrophy in response to fibrosis (Sabourin).

The latter class of explanation (B) can clearly be ruled out of court, since many polycystic kidneys present no evidence of fibrosis.

According to Herring, Schreiner, Carl Hüber and Bryce the ureter, pelvis, and collecting tubules of the kidney arise as blind epithelial outgrowths from the walls of the Wolffian duct and grow into the metanephric blastema. The secreting tubules arise from epithelial cell masses in the blastema of the metanephros, and are at first blind, so that they have to obtain a secondary connection with the primitive collecting tubules before they can discharge their contents to the exterior.

If this description be correct it is easy to understand how any number of these primitive tubules may fail to develop properly and obtain this secondary connection, and may thus give rise to cysts scattered throughout the kidney in early life in the fœtus or infant or may lie latent till adult life is reached, and then begin to form cysts. The generalised fibrosis is a secondary phenomenon, and its common occurrence can be explained in two ways:

1. The kidney as a whole is congenitally feeble, and falls a ready prey to sclerosing influences.

2. The fibrosis is produced by the widespread irritation caused by the growth of the cysts.

Symptoms and Signs.

In 25 per cent. of the cases the condition is an *autopsy finding.*

In the fœtus the tumour may obstruct delivery.

In infants bilateral renal tumours are present, there are other congenital malformations, and death occurs in a few years from uræmia.

In adults three stages can be distinguished:

1. *The latent stage.*
2. *The stage of renal tumours and hæmaturia.*
3. *The uræmic stage.*

1. *The latent stage* may last for ten years or more, the tumour being discovered accidentally and causing no symptoms.

2. *The second stage* is marked by the presence of renal

tumours. It is said that it is uncommon to feel both kidneys enlarged, but more careful routine abdominal palpation, using an efficient method, will be found to falsify this statement, for though one kidney is always larger than the other both can usually be felt. Each swelling presents the classical signs of renal tumour; it feels elastic and solid, and does not yield evidence of fluctuation, and the bosses on the surface may be felt.

Renal pain and renal colic may be caused by clot colic, by hæmorrhage into the cysts, or by undue mobility of the enlarged organ.

Intermittent attacks of hæmaturia, often painless, are very frequently met with, but differ in no way from similar attacks in patients afflicted with chronic interstitial nephritis. Apart from hæmaturia the urine shows no changes. During these attacks the cystoscope will reveal bleeding from one or both ureters, and urine from each kidney may be drawn off and tested.

3. *In the third stage* symptoms and signs of chronic interstitial nephritis appear, urinary, gastro-intestinal, nervous, cardio-vascular, pulmonary and general; death ensues from chronic uræmia, cerebral hæmorrhage, or lung complications.

In adults associated congenital deformities are not common.

The course of the complaint is variable, but on the whole benign. Some of the victims attain length of days and die of old age; the majority succumb towards the end of middle age to chronic nephritis; a few develop other diseases of the kidney such as infection, neoplasm, or movable kidney and hydronephrosis. From the point of view of prognosis life will be cut short by uræmia in middle age in 75 per cent. of the cases.

Diagnosis.

The diagnosis is difficult, unless both kidneys are easily felt to be much enlarged in the absence of urinary changes, and if the liver and spleen are also enlarged the suspicion is raised almost to a certainty, especially in children. Patients with signs of chronic interstitial nephritis, in whom both kidneys are grossly enlarged, will usually be found to be suffering from this disease.

The condition is most often mistaken for a *neoplasm,* the onset in a middle-aged patient of painless hæmaturia leading to examination, and the discovery of an enlarged kidney on

one side. Hypertrophy of the opposite kidney is unusual in neoplasm, so that if the opposite kidney is felt to be at all enlarged, presumption against neoplasm is strong.

In polycystic disease the blood will probably be found to issue from *both* ureters, and eventually the course of the disease will decide the question.

The tumour can usually be distinguished from *hydronephrosis* by the fact that the size does not vary with attacks of pain but grows progressively larger; at the same time sudden hæmorrhage into a cyst may cause pain, accompanied by sudden increase in size of the tumour, which does not, however, diminish in size when the pain ceases.

Double large white kidneys and amyloid kidneys are not likely to cause mistake if complete examination of the patient has been made, in the latter case the presence of a chronic suppurative focus or obvious signs of congenital syphilis suggesting at once the amyloid nature of the enlarged kidneys.

We have seen the enlarged kidneys and attacks of hæmaturia met with in acute lymphatic leukæmia simulate the disease, but in such a case examination of the blood is diagnostic.

Treatment.

The main lines of treatment are the same as for chronic interstitial nephritis. The disease is so seldom unilateral that surgical interference is hardly ever called for. Even though one kidney may appear clinically and at operation to be free, yet, after nephrectomy on the other kidney, the disease springs into prominence in the sole surviving kidney, showing that it was really present in a latent condition all the time.

Nephrotomy, with puncture of the affected cysts, may sometimes be considered if there is persistent unilateral renal pain caused by hæmorrhage into the cysts or by clot-colic. Relief has been reported after such manipulation, but the patients are by that time bad subjects for operation, hæmorrhage being essentially a sign of chronic nephritis. It is never justifiable to perform nephrectomy under such conditions.

3. Simple Cysts.

Simple cysts are rare, affect one kidney only, are single and unilocular, and run a benign course, being met with most frequently in middle-aged women.

They arise in the cortical portion of the kidney and grow

outwards into the surrounding tissues, and have a thin translucent wall which is intimately adherent to the renal parenchyma and resists enucleation, being composed of fibrous tissue lined by flattened epithelium. They contain fluid which may be clear, colourless, or straw-coloured, and show nothing but a trace of albumen. Old and degenerated cysts may show fibrosis and calcification of their walls, and the fluid may become colloid or contain altered blood and cholesterin; they may attain a great size and come to fill most of the abdomen.

The origin of these cysts is unknown, but probably they arise from embryonic rests of a single, blind, primitive metanephric or mesonephric tubule. They are easily distinguished from all other forms of renal cyst.

Clinically they present themselves in middle-aged women as cystic swellings of doubtful origin and attachment, causing symptoms from their large size.

The diagnosis is seldom, if ever, made apart from exploratory laparotomy, and the cyst has then to be distinguished first from other abdominal cysts, and secondly from other cysts of the kidney, especially hydatid cysts. Hydatid cysts present a characteristic thick wall which is a brilliant bluish-white, and shells away readily from the surrounding tissues.

The prognosis is excellent if an early operation be performed.

Treatment is difficult except in early cases, as the cysts will not shell out but need to be dissected out of their bed. In early cases a partial nephrectomy is the easiest course to pursue and gives the most satisfactory results. In later cases the cyst may be tapped, filled with paraffin, and an effort made to dissect out the wall complete, though this may prove a difficult operation, for which reason some prefer to "marsupialise" the cyst after having painted the interior with pure carbolic or nitric acid, afterwards neutralised by sodium bicarbonate solution. The cavity is packed with gauze, and gradually becomes obliterated from the bottom by the growth of granulation tissue.

4. Degeneration Cysts.

Sarcomata and epinephromata give rise to cysts from mucoid and hæmorrhagic degeneration.

5. Hydatid Cysts.

Ætiology.

The adult worm, the *Tænia echinococcus*, inhabits the intestines of the dog tribe, is 4 millimetres long, and possesses but four segments. The eggs reach the alimentary canal of man either from the drinking-water or from the habit of licking the master's hand, and develop into a six-hooked embryo. The embryo penetrates the walls of the stomach and enters the portal vein, in which it is carried usually to the liver and lung, rarely to the kidney, becomes encapsuled in the tissues, and grows in the course of six months into a hydatid cyst. As regards the organs most frequently attacked, taking a large series Morris states that the hydatid cyst appears in the kidney in 1 to 5 per cent. of the cases. In the human subject it is not common for more than one cyst to be present in the body at the same time, though occasionally many are present—an unaccountable fact which is worth remembering in giving a prognosis and in undertaking treatment.

The cyst may lie in any part of the kidney and pushes the kidney substance aside, producing a fibrosis limited to the neighbourhood of the cyst. Three layers may be distinguished:

1. *A false, thin outer capsule* formed of fibrous connective-tissue and kidney substance, well supplied with blood-vessels.
2. *The true outer chitinous capsule* of the cyst, which is a quarter of an inch thick, stout but friable, and of a characteristic opaque, bluish-white colour.
3. *The inner parenchymatous layer of the cyst,* which is lined by scolex heads and hooklets, and may produce daughter-cysts.

The contained fluid is opalescent, of low specific gravity (1004 to 1014), contains a trace of albumen, sodium chloride, and toxic bodies, which are very irritating if allowed to escape into the tissues, and may give rise to urticaria and general toxic symptoms. Innumerable daughter-cysts may be present, lying free in the cyst cavity or attached to the inner wall. The microscope reveals the presence of the characteristic hydatid hooklets and embryonic scolex heads.

Complications.

1. *The cyst may burst* and discharge its contents; in the vast majority of cases it bursts into the ureter, and the daughter-

cysts are discharged into the bladder; rarely it bursts into the lung, peritoneum, gut, and on to the skin.

2. *Suppuration* in the cyst.

3. *The fluid may dry up,* the walls become calcified, and the contents sterile.

4. *The cyst may cause pressure* on important structures in its neighbourhood.

Clinically the condition reveals itself as a painless cystic swelling in the region of the kidney, whose exact nature can seldom be determined except by exploratory operation.

Symptoms of pain and pressure may be caused by the mere size of the swelling, and rarely the condition may be revealed by the passage of daughter-cysts down the ureter accompanied by colic, and the cysts have even been seen escaping from the ureter by the cystoscope (Hurry Fenwick), or been found in the urine.

The cysts may burst into the lung and be coughed up, or into the tissues and cause severe toxæmia and urticaria, followed by suppuration. Suppuration leads to pyrexia, pain, increase in the size of the cyst, and demands immediate exploratory incision.

Diagnosis.

In countries such as Australia, where hydatid cyst is common, or if the patient has already suffered from hydatid cyst in other organs, a provisional diagnosis is often possible. Hydatid cysts may occur in patients who have had no relations with dogs. A rounded, painless swelling projecting from the kidney may be a solid neoplasm or a cyst. Fluctuation is a sign of very doubtful value, as soft, solid sarcomata may yield it, and cysts often fail to yield it. Hydatid fremitus if present is diagnostic, but is so rare as to be of little value. It is produced by the succession of daughter-cysts. The passage of hooklets in the urine or of daughter-cysts down the ureter reveals the fact that a hydatid cyst is present, but not necessarily that it is in the kidney itself. The presence of a large number of coarsely granular eosinophile leucocytes in the blood will suggest hydatid cyst: but eosinophilia is the exception rather than the rule.

Practically the absolute diagnosis is seldom made apart from exploratory operation, but *it should be evident directly the white chitinous wall of the cyst is exposed.*

Prognosis.

Spontaneous cure is so rare that it should never be reckoned upon. If left to itself a hydatid cyst of the kidney will burst in some direction, the accident being either fatal in a few days, if the peritoneum or lung be attacked, or leading to infection of the cyst and slow exhaustion of the patient by toxæmia. Early operation holds out a certain means of cure.

Treatment.

Subcutaneous acupuncture of an abdominal swelling or cyst through the belly wall is extremely hazardous, and should never be carried out at the present day.

The swelling should be fully exposed by the usual lumbar incision till the white chitinous wall of the cyst is reached, which at once reveals the true nature of the condition. The tissues should be well protected by gauze pads and the contents of the cyst can then be partially evacuated by a large trocar and cannula. The cannula is removed, and the opening closed by a pedicle clamp. The walls of the cyst collapse and peel themselves off the surrounding tissues, aided if necessary by the gloved finger of the surgeon, and the complete cyst can then be lifted out of the wound, in which way all chance of recurrence is avoided. A large cavity is left, lined by vascular fibrous kidney substance. If bleeding is excessive, the cavity is packed with dry sponges wrung out of a hot solution of adrenalin (1 : 100,000; temperature, 115° F.). After a few minutes the sponges are removed one by one, the bleeding points caught and tied with catgut ligatures. An effort is made to obliterate the cavity by the insertion of purse-string sutures round the walls of the cavity, the deeper ones being applied and tied before the more superficial. If the cavity can be completely obliterated the wound can be closed and should heal by first intention. If it cannot be obliterated or if the bleeding cannot be stopped, it must be plugged firmly with dry sterile gauze and allowed to granulate up from the bottom. A sinus is left which requires careful dressing for some three or four months before it finally closes.

6. Dermoid Cysts.

Dermoid cysts are so rare in the kidney as to be outside the range of practice. Morris states that he could only find reports of four cases. Such cysts resemble dermoids found in other parts of the body.

7. Paranephric Cysts.

These cysts are extremely rare and are only mentioned to make the list complete. They arise in the perinephric connective tissue.

1. *Serous cysts,* which may be unilocular or multilocular, and presumably arise from embryonic remnants of the Wolffian body.
2. *Hydatid cysts.*
3. *Blood cysts* formed as the result of mechanical injury (see Ch. III).

CHAPTER XII.

ANURIA AND OLIGURIA.

Causes.

1. Obstructive.

Blocked ureter—calculus.
—pelvic tumour.
—clot.
—curd.
—kink.

2. Non-obstructive.

A. *Advanced Destruction of Secretory Cells.*

1. Toxic nephritis.
2. Microbic nephritis.
3. Neoplasm and cyst.
4. Removal of single or sole functioning kidney.

B. *Neuropathic.*

1. Reflex instrumentation, operation, trauma } of kidney, bladder, urethra. of distant parts, *e. g.* rectum.
2. Hysteria.

C. *Disease of the Blood-vessels; Ischæmia.*

1. Aneurysm.
2. Embolus.
3. Thrombus.
4. Venous congestion. Vaso-motor = fall in blood-pressure. Back pressure = weak heart.

In obstructive cases the urine is not simply dammed back until the increased pressure prevents excretion mechanically, but the kidney substance ceases to manufacture urine. This effect is produced through the nervous system, whether by indirect action in the blood-vessels inducing a low blood-pressure, venous engorgement and ischæmia, or by the direct action of true secretory nerves is hard to say. Obstructive

cases might therefore be included with justice in the reflex group. Though calculus and pelvic tumour are by far the most common causes, yet any other cause of obstructed ureter may at times produce oliguria and even complete anuria.

In non-obstructive cases there is no difficulty in understanding the action of those agents which destroy the kidney cells too extensively or too suddenly for compensation to occur.

Vascular derangements of the kidney may account fully for some cases of anuria. Ischæmia may act alone and produce necrosis of the secretory cells, as in cases of aneurysm, embolus, and thrombosis of the renal vessels or of the aorta, and in cases of failing heart causing venous stagnation; but in many cases there is a reflex vaso-motor effect whereby the general and local blood-pressure falls to such a pitch that secretion becomes impossible. Patients with diseased kidneys may develop a high general blood-pressure (150 to 250 mm. of mercury) to enable kidney secretion to be carried on. In such patients a relative fall to the normal and an actual fall of 50 to 70 mm. of mercury may determine the onset of anuria. Again in healthy individuals a fall in blood-pressure of 50 to 70 mm. of mercury may be sufficient to cause anuria. Such falls are seen after severe operations which cause shock, the main feature of which is a depression of the vaso-motor centre and a fall in blood-pressure, after instrumentation of the urethra and bladder, after severe injuries to the kidney and other organs, and in cases of fractured spine.

In dealing with a case of anuria it is essential to make an accurate diagnosis. This has already been considered in Ch. V.

All cases of anuria should be submitted at once to complete X-ray examination. If calculi are found the kidney last affected should be exposed and drained, and the calculus removed at once or at a second operation. In doubtful cases both kidneys should be drained.

If the general blood-pressure be too low as is the case in shock, attempts should be made to raise it by bandaging the limbs and abdomen, lowering of the head, intra-venous infusion of salt solution (three pints), and the exhibition of certain drugs such as ernutin (ɱv subcutaneously hourly for four doses), digitalin (gr. $\frac{1}{100}$ four-hourly), spartein sulphate (gr. $\frac{1}{60}$ four-hourly, four doses), intra-venous injection of

adrenalin (1 : 100,000 aqueous solution, one drachm every five minutes). Pituitary extract is likely to prove of great value in these cases, when its dosage has been satisfactorily worked out.

It is not yet decided as to whether there are true secretory nerves passing to the kidney which can increase or inhibit secretion of urine, or whether the variations in the quantity and quality of the urine are produced by vaso-motor action. Whatever the exact mechanism there is no doubt from clinical experience that the secretion of urine can be profoundly affected through the nervous system. The effect of mental action is seen in the oliguria of hysteria and the polyuria of excitement, fear or worry. The effect of reflex action is seen in the anuria that may follow instrumentation of the urinary tract, the blocking of one ureter by a calculus, the other kidney being free and healthy, the oliguria and polyuria of hydronephrosis that may be cured by nephrectomy, and so forth. Reflex anuria undoubtedly can occur, and one or both kidneys may be comparatively healthy, and can be restored to work if the source of irritation be removed.

In toxic nephritis medical treatment is pushed vigorously, hot packs with pilocarpin nitrate gr. $\frac{1}{10}$ before each, watery purges, cupping of the loins, hot rectal saline infusions, or venesection combined with intra-venous saline infusion. If there is any chance of saving the patient these measures usually suffice, but it has been proposed to cut down upon both kidneys after three days' complete anuria, and decapsulate them with the idea of relaxing the intra-capsular tension, and preventing pressure necrosis of the cells. This step can have no effect on the poison in the blood, but is worth a trial.

In microbic nephritis it is clearly justifiable to expose the kidneys and drain them, and if the disease is unilateral nephrectomy should be considered.

CHAPTER XIII.

THE SURGICAL TREATMENT OF BRIGHT'S DISEASE.

Of late years attempts have been made to apply surgical measures for the relief of Bright's disease (Harrison, Morris, Edebohls, etc.).

Bright's disease includes the various forms of acute and chronic nephritis caused by dead irritants or poisons such as those produced in the course of acute specific fevers, severe burns, prolonged exposure to cold; metallic, vegetable and animal poisons, *e. g.* mercury and lead, turpentine, cantharides and alcohol, gout, etc.

These poisons may give rise to single or recurrent attacks of acute inflammation of the kidney as a whole, parenchyma cells, interstitial tissue cells and blood-vessels, and are very likely to lead to a degeneration of the higher cells of the kidney with increase in the interstitial tissue and diminution in the blood supply, which degeneration may be continuous and progressive, or may be self-limited and correspond in amount to the severity of each attack.

Two methods of procedure suggest themselves.

A. In first attacks of acute toxic nephritis, degeneration of the cells may be produced in two ways:

1. By the direct action of the poison in the blood.
2. By direct mechanical pressure injury to the cells, and by the ischæmia produced by increase in the intra-capsular tension.

The relative importance of these two factors is by no means settled, and it is argued from the effects of inflammation elsewhere, and the relief afforded by incision of the tissues and relaxation of tension, that benefit should be obtained in acute nephritis by exposing the kidney, and either incising the capsule or stripping it completely away. Such benefit has, indeed, been observed in a few cases operated upon under a mistaken diagnosis. The question can only be settled by practical experience, but at present it is hard to obtain the physician's consent to such a course early in the disease when the procedure might be expected to save the kidney substance

from destruction. In early cases, when pain is severe and the blood-pressure not markedly raised or lowered, it can be argued that such a course is justifiable if the physician's consent can be obtained, that it will not increase the patient's risks, and that it may prove to be a means of saving the lives of many kidneys which are now possibly sacrificed to expectant treatment.

Attempts should be made to relieve the blood of the poison by bleeding the patient a pint and a half and injecting three pints of normal salt solution into a vein, and by maintaining a copious flushing through of the kidneys and tissues by large draughts of water, combined with free diaphoresis, diuresis, and watery evacuations from the colon.

The chief objections that may be urged against decapsulation are—first, the risk of administering anæsthetics, all of which are kidney poisons, and the risk of shock, though if spinal anæthesia be employed these risks are reduced to the minimum.

Nephrotomy and decapsulation may be considered as worthy of trial in first or early attacks of acute nephritis, either:

1. As a routine measure early in the course; or—

2. As a last resort in cases where suppression of urine has lasted for three days in spite of treatment.

The results should be carefully noted, and compared with a comparable series of cases treated purely by internal medication.

B. In cases of chronic toxic nephritis decapsulation has been proposed and carried out for two conditions:

1. As a routine measure with the idea of increasing the blood supply of the degenerated organ (*cf.* epiplopexy for cirrhosis of the liver).

2. As a palliative measure to relieve recurrent attacks of pain and hæmaturia.

Edebohls has been the advocate of the routine treatment, but a perusal of his cases does not give confidence that his diagnoses are always correct, which vitiates his conclusions. Undue mobility of the kidney may give rise to the presence in the urine of albumen and casts, a condition which may be completely relieved by anchoring the organ. The cases of Edebohls that are reported as doing well appear to have belonged to this group rather than to that of chronic toxic nephritis. At the same time it is possible to make out a case for the operation, if the experimental results of certain authors be accepted.

Tuffier and many others find by experiment that decapsulation of a kidney leads to the increased formation of stout fibrillar bands running from the surrounding tissues into the cortex of the kidney and carrying fresh blood-vessels which bring blood to the kidney, and Tuffier found that after decapsulation he could even tie the renal vessels and the kidneys remained alive and healthy nourished by their new vessels. It is only fair to state that many other experimenters find exactly opposite results, and state that decapsulation decreases the blood supply of the kidney. Clinical experience with nephropexy in the human would seem to support the first view. Absolute asepsis must be maintained.

It appears justifiable to offer such treatment to a patient with chronic nephritis, seeing that medical treatment does not profess to be curative, as the question can only be solved by practical experience. Even if anæmia, œdema, and hyperpiesis be already present, we might hope to improve these conditions if decapsulation produced increased blood supply and a chance for the kidney to undergo further compensatory hypertrophy.

At the same time the kidney must be protected from the further action of the poison whenever this is feasible, such as lead and alcohol.

The results in the few genuine cases operated on have not so far been very encouraging, except in a few isolated instances, but the cases were obtained in the late stages of the disease.

Decapsulation has been suggested as a palliative measure to relieve hæmaturia and pain. The hæmaturia would appear to be caused by the raised vascular tension, so that it is difficult to see how this could be relieved by decapsulation. At the same time, exploration is justifiable for the persistence of such symptoms, and it has been found by experience that decapsulation may give considerable relief. If the blood-pressure is very high, or the degeneration advanced, the risks of shock and the anæsthetic are not to be lightly brushed aside.

The last word can by no means yet be said on this subject. Further experimental work is necessary, and the publication of full reports on cases completely examined previous to treatment, and watched for many years after treatment, and compared with control cases treated by purely medical measures.

CHAPTER XIV.

RENAL PAIN AND HÆMATURIA OF UNKNOWN ORIGIN.

In any large clinical field sporadic cases turn up not infrequently with complaint of renal pain and hæmaturia, for which no adequate cause, local or general, can be found. Investigation is undertaken for *local causes* such as mechanical injuries, stones, parasites, inflammation and cysts of the kidney, ureter, bladder, prostate, urethra, and genital glands and ducts, and for *general causes* such as disease of the kidney cells, toxic nephritis, diseases of the blood-vessels, aneurysm, embolus, back-pressure, raised blood-pressure, diseases of the blood, hæmophilia, hæmoglobinuria, purpuras, scurvy, leukæmias, anæmias, etc., and diseases of the nervous system, *e.g.* hysteria.

When all these causes have been considered, cases yet remain which it is impossible to ascribe to any of them and in which complete examination of the excised kidney by methods at present available, when opportunity arises, has failed to reveal any lesion. Much speculation, so far fruitless, has arisen in regard to these cases.

Certain authors invoke various hypothetical causes, saying that some cases are caused by a slight jar, which bursts a small blood-vessel, others by a "local hæmophilic condition," others by angio-neurotic changes, comparable to certain obscure cases of hæmatemesis and hæmoptysis and metrorrhagia.

There is no doubt that we are still very much in the dark as to the true causes of bleedings from mucous membranes, especially in women, and in all probability a single group of causes will eventually be found to explain them all. At the same time it is permissible to think that many cases are reported and accepted as cases of "essential hæmaturia" in which complete examination would have revealed some simple cause, and that as our methods of exact examination improve more and more, so these cases will be reported less and less.

In a number of these cases no note is made of the general

blood-pressure, and in our experience a greatly raised general blood-pressure is not uncommonly a cause of hæmaturia.

Other causes that are very liable to escape notice are the presence of a small angeioma of the renal pelvis, an undoubted cause of obscure hæmaturia (Hurry Fenwick), small patches of submucous tubercles lying on a renal papilla, a tiny stone buried in the pelvis or a calyx, and an abnormal "tail artery" bowstringing the ureter.

Israel considers that many of these cases are due to a one-sided nephritis of any anatomical variety in which the urine is free from albumen and casts.

Anyhow, the fact remains, and must be remembered, that certain patients experience pain in one or both kidneys and bleed intermittently from one or both ureters in whom no local or general cause can be discovered to account for the symptoms. The bleeding may continue on and off for months or years, or may cease spontaneously or after any operation on the kidney.

If it is certain from ureteric meatoscopy that the bleeding always comes from one kidney, that kidney should be exposed by lumbar incision, and the upper end of the ureter examined for abnormalities. The kidney is then examined for stone, neoplasm, and tuberculosis, and the pelvis opened up either through the bloodless line of the cortex or by a direct incision parallel to the long axis of the ureter. Search is made for a small stone, patches of tuberculosis, or an angeioma. A small portion of the kidney is removed for further investigation with the microscope.

The kidney is then decapsulated—as it is found by experience that decapsulation often cures the symptoms—and dropped back into its bed. The patient is kept with the feet up for ten days or a fortnight till the kidney has healed into its proper position in the loin.

In a fair number of cases (Israel, six out of fourteen) the symptoms will not recur. If they do recur, and are sufficient to interfere with the patient's occupation, or threaten his life, then it is justifiable to remove the kidney, if the surgeon is certain that the bleeding is always unilateral and that the other kidney appears healthy. A certain number of cases of cure after this procedure have been reported.

Case-records have appeared lately in the literature in which the mere act of catheterising the ureters has been followed by complete and permanent cessation of the bleeding.

SECTION II.

DISEASES OF THE URETER.

CHAPTER I.

CONGENITAL ABNORMALITIES OF THE URETER.

The development of some of the congenital defects of the ureter have already been dealt with in Ch. II, Sect. I, where the meaning of double and multiple ureters, of valves, twists, kinks, and abnormal blood-vessels was referred to.

Abnormal terminations of the lower end of the ureter.—The ureter arises as an outgrowth from the Wolffian duct, but it shifts its lower opening from this position and acquires a new opening into the wall of the bladder. In this way can be understood such abnormalities as an opening into the vas deferens, or into the urethra, vagina, and rectum, parts of the entodermal cloaca along the wall of which the opening of the ureter has to travel on its way to the bladder-wall. These abnormal endings are usually associated with a congenital stricture. The treatment consists in isolating the lower end of the abnormal ureter, cutting it across, and fixing it into the wall of the bladder (cysto-ureterotresis).

When congenital stricture occurs at the lower end of a ureter normally placed, a ballooning or cystic dilatation of the ureter is produced just above the stricture, which becomes prolapsed into the bladder cavity, giving rise to a characteristic cystoscopic picture. The prolapsed cyst is seen to fill slowly with urine, until a contraction of the ureter takes place, when urine is shot forth from the narrowed mouth and the cyst collapses, a process which is repeated every half minute or so. Dilatation of the ureter and hydronephrosis occurs above the stricture. The treatment consists in cutting away the prolapsed ureter and uniting the cut ends with a few catgut stitches.

Congenital dilatation.—A condition has been described by Shattock in which the ureters and bladder are dilated and hypertrophied, yet no cause of obstruction can be found. This condition appears to be a form of congenital sport comparable to the similar condition of the colon known as Hirschsprung's disease.

STRICTURES OF THE URETER.

1. CONGENITAL.
2. ACQUIRED.
   - (*a*) Following injuries—subcutaneous rupture.
     —operations.
   - (*b*) Following ulcers—chronic ureteritis.
     —tuberculosis.
     —calculus.
   - (*c*) Carcinoma.

The congenital are often associated with other congenital sports, and are by far the more common variety (see Ch. VI, Sect. I).

The acquired may arise from chronic ureteritis set up by secondary tuberculous infection from the kidney or bladder, from primary tuberculosis, from an ulcer produced by an impacted calculus, and after injury to the ureter during operations, or by subcutaneous rupture. Carcinoma is usually secondary to a tumour of the kidney and is extremely rare.

The results of a stricture are hydronephrosis and pyonephrosis (see Chs. VI, VII, Sect. I).

The diagnosis is made by a process of exclusion in searching for causes of hydronephrosis or pyonephrosis. The hydronephrosis is unilateral; stone, an uncommon cause, has been excluded by X-ray examination, and an obstruction or narrowing is detected in the ureter by means of a ureteric bougie. If the obstruction is in the lower end of the ureter, and pelvic tumour and stone have been excluded, it is possible to divide the stricture in women with a suitable internal ureterotomy knife through a Kelly's tube. If the obstruction be high up above the brim of the pelvis it is wiser to explore the ureter by the lumbar extra-peritoneal route to determine and remedy the cause of the trouble.

Ureteral obstruction leading to one-sided hydronephrosis when partial or to atrophy of the kidney when complete, has been described in Ch. VI, Sect. I, but the causes are

enumerated here again, as they must be remembered in the differential diagnosis of stricture of the ureter.

(1) *In the lumen* —calculus.
—foreign bodies.

(2) *In the wall* —strictures.
—valves.
—kinks.
—twists.
—ulcers.

(3) *Outside the wall* —pelvic tumour.
—movable kidney.
—aberrant blood-vessels.
—inflammatory bands and adhesions.

CHAPTER II.

URETERIC CALCULUS.

Ætiology.

Most of the stones found in the ureter have been formed in the kidney, and have become impacted in the ureter during an unsuccessful effort to descend to the bladder. Primary calculi formed locally in the ureter are almost unknown, but secondary calculi are occasionally formed around foreign bodies such as silk sutures or parasites.

Pathology.

The stones are nearly always ovoid and elongated, of a size small enough to enter the ureter but too large to be able to complete the passage, seldom more than half an inch by one third of an inch in their long and short diameters. They are usually primary, uric acid, lime oxalate or lime phosphate stones, and are seldom covered with a mortary layer of secondary phosphatic deposit. They may be single or multiple, and are often accompanied by stones both in the kidney and bladder.

Smooth uratic stones seldom become impacted, as they do not irritate the wall of the ureter sufficiently. The spiculated oxalate and the rough calcium phosphate varieties are those that become impacted, at first by a process of œdema of the mucous membrane and spasm of the muscular coat of the ureter; so that in the early stages it is often possible to shift the stone by diuresis and drugs. After some months the stone becomes permanently fixed from the effects of inflammation, which leads to ulceration and stricture at the site of the stone. The sites of election for impaction are first at a point one inch below the pelvic mouth; secondly, in the pelvic ureter between the brim of the pelvis and the wall of the bladder.

(A) Effects on the Kidney.—Complete plugging leads to atrophy of the corresponding kidney, but incomplete plugging leads to nephrectasis. Secondary infection of the distended kidney is seldom long delayed, so that hydronephrosis is not

often met with clinically in combination with ureteric calculus, pyonephrosis being the usual condition found.

(B) EFFECTS ON THE URETER.—In similar conditions the ureter above the calculus may undergo atrophy, or become dilated and its walls hypertrophied.

At the site of the stone chronic ureteritis appears, the mucous membrane ulcerates, the muscle fibre degenerates, and the connective tissue undergoes hyperplasia, so that a stricture is gradually formed which prevents the onward progress of the stone, and may give a great deal of trouble after the stone has been removed if it does not receive proper attention at the time of the operation. The peri-ureteric fatty tissue often undergoes hyperplasia, and is converted into a diffuse semi-cartilaginous fibro-lipomatous mass, which can be felt as a hard cord in the abdomen or pelvis and leads to retraction of the vesical mouth of the ureter. Abscesses may arise in the midst of the mass, and if they burst on the surface will lead to fistulæ, through which the stone may be discharged spontaneously.

Malignant disease may arise in the site of an ulcer caused by a stone, but this complication is very rare.

Symptoms.

The symptoms of a ureteric calculus are the same as those of a renal calculus (see Ch. V, Sect. I), a fact which cannot be too much emphasised.

Symptoms of stone in any part of the urinary tract should mean an exploration of the whole tract. It is no use treating a stone in the bladder or kidney if at the same time the ureter is blocked with a small stone, or a stone in the bladder if the kidney is full of stones. Radiography and the ureteric bougies have simplified the task of discovering quiescent stones in any part of the urinary tract when one of the stones has started to give trouble. Kidneys have been unsuccessfully explored for calculus, when all the time a complete X-ray examination before the operation, or the passage of a ureteric bougie during the operation, would have revealed a small calculus in the corresponding ureter, the real cause of the symptoms. When a stone is travelling down the ureter the pain tends to present the type of severe colic, which radiates along the linea semi-lunaris downwards into the testicle or labium majus, and into the thigh, but this type of colic is sometimes seen even though there is only a single stone present in a dilated renal calyx, so that it cannot be taken as

characteristic of a ureteric calculus. Even when a stone has been impacted for many years in the ureter attacks of colic occur from time to time, with long intervals of complete relief.

Signs and Diagnosis.

The kidney may not be felt, or it may form a large tender pyonephrosis, seldom a hydronephrosis.

The stone itself, or more often the thickened ureter around the stone, may sometimes be felt by abdominal palpation, but the practitioner need not expect to be able to feel it in the majority of cases. By rectal or vaginal examination the stone is much more easily felt if it is in the pelvic ureter, but it should not be mistaken for ureteritis due to tuberculosis.

The urine may be clear, or it may contain blood or pus, and the persistent presence of crystals is significant, though not diagnostic.

With the cystoscope the mouth of the ureter may be seen to be puffy and inflamed, or in chronic cases drawn out and patulous, and extruding ropes of pus from time to time.

In doubtful cases urethral obstruction may be confirmed by the passage of ureteric bougies and catheters.

Radiography, in its recent developments, gives a certain means of diagnosis of ureteric calculus in nearly every case, but the interpretation requires considerable skill and judgment, as the conditions which may simulate ureteric calculus are far more numerous and deceptive than in the case of renal calculi. Especially deceptive are phleboliths in the pelvic veins, and to a less extent calcareous glands.

If a shadow is to be accepted as evidence of a ureteric stone:[1]

1. It must lie in the line of the ureter.
2. It must be ovoid or elongated in one axis (rounded stones being very rare in X-ray examinations).
3. Its long axis must point downwards towards the bladder. (A large pelvic shadow transversely placed is cast by a stone in the bladder.)
4. The clinical history should reveal intermittent renal suffering.

The line of the ureter is divided into three parts:

1. The loin line (A. B. in figure), which forms a vertical line touching the tips of the lumbar vertebræ from the second downwards.

[1] For further evidence see 'The Value of Radiography in the Diagnosis and Treatment of Urinary Stone,' E. Hurry Fenwick, J. & A. Churchill, 1908, Ch. VI, *et seq.*

2. The sacral wing line (B. C.).
3. The pelvic cavity line (C. D.).

Visual fallacies in the radiography of ureteric calculus:

1. Phleboliths.
2. Calcareous lymphatic glands.
3. Patches of atheroma in vessels.
4. Appendicular concretions.

1. *Phleboliths.*—Phleboliths in the vesico-prostatic plexus are extremely common, as they occur in one out of every five subjects over thirty years of age. They cast a *circular* shadow on the plate with a sharply cut border and a bright homogeneous surface. The shadows are very near the line of the ureter, but if multiple a line drawn through their centres does not often correspond to the axis of the ureter.

Their shadows may be as large as that of a small ureteric calculus (10 by 6 mm.). In cases of doubt an iron oxide bougie should be passed up the ureter and a second radiogram taken.

2. *Calcareous glands.*—These are uncommon in the pelvic area, but are seen along the sides of the vertebræ and along the sharp brim of the true pelvis. In most cases their irregular shape, their rounded and indefinite edge, their multiplicity and axial lines are sufficient to exclude calculus, but if a single shadow appear in the line of the ureter the diagnosis may be difficult, and can only be settled by the ureteric bougie.

3. *Patches of atheroma* in the iliac arteries appear as diffuse irregular patches which are seldom in the axial line of the ureter.

4. Most *appendicular concretions* are fæcal and do not cast a shadow, but in rare cases when the contents have become calcified the mimicry of a ureteric calculus may be very close; in one case the condition was only confirmed by exploration.

Complications, Course, and Prognosis.

In many cases the disease runs a prolonged course of ten to twenty years, marked by recurring attacks of pain and hæmaturia, the kidney being small, atrophic, and free from bacterial infection. Sooner or later in nearly all cases infection occurs, either of the kidney or at the site of the calculus, and leads to attacks of pyrexia with inflammation and abscess of the kidney, ureter, and surrounding tissues, which eventually prove fatal. In other cases the disease is cut short by calculous anuria (see Ch. V, Sect. I).

A patient with an impacted ureteric calculus is ever in

jeopardy, as fatal complications may arise at any moment, so that surgical treatment should be strongly urged upon the patient while he is in fit condition to stand it with safety.

Differential Diagnosis.

This is the same as for cases of renal calculus (see Ch. V, Sect. I), but *the surgeon should never rest content with a diagnosis of renal, ureteric, or vesical calculus alone, until the whole of the urinary tract on both sides has been submitted to the X rays.*

Treatment.

The general treatment follows the same lines as those laid down in Ch. V, Sect. I. If the symptoms are recent, and a small oval shadow is seen in the course of the pelvic ureter, and especially if stones have been passed before, it is advisable to employ expectant measures for some three or four months to see if the stone will pass naturally. Copious diluents are administered aided by urotropin to ward off infection, and belladonna in large doses, the attacks of colic being palliated by hot baths, antipyrin, and morphia. If the stone has not passed in three to four months another radiogram is taken. If the stone has shifted downwards, expectant treatment should be persisted in for another two months at least. If it has not shifted at all, and anyhow after six months of unsuccessful treatment, it is time to advise operation.

Operation should be performed without delay if there are signs of infection or of calculous anuria.

The following routes may be adopted to reach a stone in the ureter:

1. The lumbar.
2. The inguinal.
3. The parasacral.
4. The vaginal.
5. The vesical.
6. The pre-rectal.

For practical purposes there are few stones that cannot be reached by the combined lumbo-inguinal or by the inguinal incision, which permits of exploration of the kidney at the same time if necessary.

Stones that are too low down for this route can nearly always be reached by the vaginal or vesical route, but a few remain for which it becomes necessary to employ the parasacral or pre-rectal routes, the other routes having failed.

It is sometimes possible to dilate the vesical orifice of the ureter or even cut it with a ureterotome in the female, so that a stone impacted at the entrance of the bladder can be passed into the bladder and captured with a lithotrite.

Certain practical points must be observed in dealing with any stone in the ureter. Whenever possible the stone should be pressed up into a more healthy portion of the ureter so that the incision shall be made through healthy tissues and into a tube of larger calibre. The incision is longitudinal and is best united with fine catgut, but in doubtful cases healing will occur if the ureter be simply dropped back into the wound and a drainage-tube passed down to it. Before the ureter is stitched up a bougie should be passed both up and down to see if the rest of the ureter is clear of stone and stricture.

If the urine is aseptic there is no need to explore the kidney if it is known to be free from stones, and the ureter will heal without stricture or fistula.

If the urine is infected the problem is more complicated.

A stricture will generally be found at the site of the stone, which may progress and lead to the death of the kidney. This stricture may be remedied by Fenger's method of urethroplasty or by internal ureterotomy with a ureterotome. If too severe for either of these measures it may be possible to resect the stricture or perform cysto-ureterotresis. When, however, the stricture is so severe that the kidney has been greatly damaged by back-pressure and infection, and if the opposite kidney is known to be free from calculus and infection and to be capable of carrying on the total renal function, it is generally better to perform nephrectomy as well. In cases of doubt the kidney should be left, adequate drainage provided, and the question of secondary nephrectomy can then be dealt with later if the fistula refuses to heal or if the infected kidney threatens the general health.

With the modern methods of diagnosis ureteric calculi will be operated upon early in the aseptic stage more and more, and rapid healing without any damaging after-results will be the rule. Early operation means complete cure.

CHAPTER III.

INFLAMMATION OF THE URETER.

INFLAMMATION of the ureter is set up by bacteria, which reach its walls in various ways. In all but a few cases they do so by direct spread along the connective-tissue spaces from a bacterial focus in the kidney or bladder—"descending" or "ascending" ureteritis; but in rare instances they can be deposited direct from the blood-stream into the tissue spaces of the ureter—"primary" infection; or they can reach the outer coat by direct tissue spread in the retro-peritoneal fat from primary foci in the retro-peritoneal and pelvic cellular spaces.

The bacteria met with are similar to those found in renal infections, chiefly bacilli of the colon group, staphylococci, streptococci, the proteus, and the tubercle bacillus, and the result varies with the virulence and numbers of the invaders and the resistance of the invaded tissues.

Any cause which predisposes to infection of the bladder or kidney likewise predisposes to infection of the ureter, especially mechanical injury, the presence of a stone, or back-pressure.

The cases secondary to disease of the kidney or bladder have been dealt with in the chapters on cystitis and pyelonephritis.

There can be no doubt that primary infections of the ureter do sometimes occur, but they must not be confused with another type of case, not uncommon, where a small primary bacterial focus is found in the kidney, which has set up a secondary infection of the ureter with advanced changes, and which might easily escape notice if not searched for with care.

In acute inflammations the mucous membrane of the ureter is reddened, œdematous, and covered with films of pus. The muscle-fibre, being poisoned by the bacterial toxins, is relaxed so that the ureter appears dilated, pouched, tortuous and thin walled. The blood-vessels are engorged and the tissues filled with round cells. The process may resolve, may lead to chronic fibrosis, or to abscess and ulceration. The symptoms resemble those of acute pyelitis, from which it is impossible to distinguish the disease during life.

In chronic cases the wall of the ureter is converted into a dense fibro-lipomatous mass of cartilaginous consistence made up of hyaline bands of connective tissue surrounding yellow areas of fat. The fibrous change involves all the coats of the ureter, and the muscle-fibre degenerates; the mucous membrane may remain intact or be extensively ulcerated, and the lumen is narrowed considerably. By the contraction of this scar-tissue the length of the ureter is diminished so that the vesical mouth of the ureter becomes drawn upwards and outwards, and at the same time becomes patulous from the degeneration of the muscle-fibre around it. The kidney shows a varying degree of hydronephrosis.

Under the microscope the main mass is seen to be made up of spindle-cells and fibrillar tissue surrounding areas packed with round cells and areas of fat cells, and the walls of the blood-vessels are thickened and fibrous. These changes appear to be produced by a chronic infection with a mild strain of the staphylococcus or proteus, or such like bacteria. In tuberculous cases the lumen is surrounded by a thick layer of tuberculous granulation tissue and the lumen is blocked with cheesy material. Giant-cell systems are seen and tubercle bacilli can be demonstrated in them.

The epithelium of the mucous membrane may undergo a cystic degeneration, small cyst-like polypi like tiny grapes being formed containing clear fluid, and scattered widely over the mucous membrane—the so-called "ureteritis cystica." Similar changes have been observed in the pelvis in cases of pyelitis, but the appearance seems to have no specific value.

From the notes of a few cases it is possible to make the following statement with regard to chronic primary ureteritis, but the diagnosis can never be absolutely certain and complete until the kidney and ureter have been removed from the body.

The symptoms are of some years' duration and suggest a chronic one-sided pyelitis. They consist of a burning pain felt after micturition, colicky pains in the loin and thigh, increased frequency of micturition by night as well as by day, and the passage of cloudy urine.

On examination the urine is acid or neutral, contains a trace of albumen and a moderate amount of pus, and specific bacteria may be isolated by appropriate methods.

The kidney on the affected side is a little enlarged and tender; the thickened ureter may be felt as a dense, tender

cord by deep abdominal palpation running down along the outer side of the bodies of the vertebræ, and the lower end can always be felt as a hard cord by rectal or vaginal examination.

Cystoscopic examination reveals a healthy bladder, but the mouth of the diseased ureter is patulous and drawn upwards and outwards, and pus may be seen issuing from it.

It is seldom possible to pass a ureteric catheter more than half an inch or so up the ureter as the lumen is narrowed to an extreme degree.

The X-ray examination is negative and an exploratory operation is performed with the diagnosis of one-sided chronic ureteritis and pyelo-nephritis. The kidney is found healthy except for an early degree of hydronephrosis, but the ureter is found in the condition described above. On the whole the best treatment is to excise the whole of the ureter and sacrifice the kidney, as it is impossible to be certain there is not a small primary focus in the kidney all the time, and this measure leads to complete cure.

Drainage of the ureter on to the loin combined with lavage and the inoculation of appropriate sera or vaccines have proved disappointing, as the sinus shows little tendency to close and the urine continues to be purulent.

CHAPTER IV.

URETERIC FISTULA.

Causes.

A. CONGENITAL.
B. ACQUIRED.
(*a*) *Accidental wounds.*
(*b*) *Deliberate surgical incision.*
(*c*) *Pathological.*

A. CONGENITAL.

Congenital fistulæ have already been described (Ch. I, Sect. II).

As they occur chiefly in monsters they seldom require treatment, and the diagnosis and treatment is the same as for acquired fistulæ. The openings may be found in the vagina, vulva, urethra or rectum.

B. ACQUIRED.

a. *Accidental:*

1. Subcutaneous rupture.
2. Penetrating wounds.
3. During pelvic operations.
4. Sloughing after prolonged labour or from prolonged wearing of a tight pessary.

The only common variety is that following pelvic operations in the female. The ureters as they run round the neck of the uterus between it and the uterine arteries are in danger of being included in a clamp during the operation of vaginal hysterectomy, and when large uterine tumours or matted masses of pelvic inflammatory tissue are being dealt with by the abdominal route the ureters may be so displaced that knowledge of surgical anatomy is no help in avoiding them, and they may be met in some quite unexpected position and be accidentally divided. During a prolonged and difficult labour the ureters may be caught between the fœtal head and the bony pelvis and undergo pressure necrosis, but it is probably only a ureter fixed by old pelvic cellulitis that can be affected thus, as the normal ureter can slip about in its bed out of harm's way.

b. *Deliberate surgical incision:*

1. *Ureterotresis, e. g.* in cases of extirpation of the bladder for growth.
2. *Incision*—to remove stones;
   —to correct strictures and valves.

The operation of ureterotresis is discussed under "Vesical Tumour" (Ch. VI, Sect. III). Permanent fistula should not follow longitudinal incision made to remove stones, etc., spontaneous closure being the rule if free drainage be established, even though no sutures have been applied.

c. *Pathological:*

Ulceration of the ureter from tuberculosis or stone.
Ulceration into the ureter of a rectal or pelvic tumour.
Ulceration into the ureter of an abscess around it.

Pathological Anatomy.

The opening may be partial in the side of the ureter, as after incision and in pathological cases, or involve the whole circumference of the ureter; or a portion of the ureter may have sloughed away as after labour or the application of a clamp. There may be a single opening or a double opening, one communicating with the renal end of the ureter, the other with the bladder. The opening is usually found on the front wall of the vagina just in front of or at the side of the cervix, but it may be on the skin, or in the uterus or intestine. The opening is usually pin-point and difficult to find, and surrounded by granulation tissue. The fistulous track is lined by mucous membrane, and the wall is formed by a dense layer of scar-tissue. The track may be short and straight, or be long and sinuous. The mouth generally becomes strictured, which leads to back-pressure on the kidney and hydronephrosis, and this predisposes to ascending or descending bacterial infection, which is seldom long delayed, and produces pyonephrosis.

Symptoms and Diagnosis.

The condition may be noticed at the operation immediately the ureter is wounded, or be discovered when the wound is dressed, urine being found in the discharges. If the operation has been an intra-peritoneal one, localised peritoneal abscess or fatal diffuse peritonitis may ensue.

If a clamp or ligature has been applied to the wall of the ureter in the efforts to control bleeding, the accident is seldom noted at the time. If both ureters have been in-

cluded, persistent anuria will lead to early diagnosis and removal of the ligatures. If only one has been included there will be nothing in the oliguria to excite suspicion, so that the condition generally escapes notice until some days after the operation, when the ligated portion of the ureter sloughs away and urine is discharged through the vaginal or abdominal wound. Some gynæcologists advocate the routine catheterisation of the ureters either before operation, the catheters being left *in situ* during the operation, or at the end of it, to make sure that the ureters are patent.

The diagnosis is seldom in doubt for long. The dressings are continually wet and emit a urinous odour, and tests applied to the escaping fluid show that it contains urea, etc.

A thorough investigation of the vagina should be made by inspection, and of the bladder with the cystoscope, and it may be possible to detect a fine opening in the vaginal scar from which urine is issuing, and up which a ureteric catheter can be passed. By means of ureteric catheterisation and inspection of the bladder wall, and if necessary the injection of coloured fluids, it is possible to determine the variety of fistula and the number of openings.

Prognosis.

Spontaneous closure is a rare event which cannot be looked for, and never occurs except in cases of partial wounds. Some patients may go on for years and the general health remain unaffected, but in most hydronephrosis and pyonephrosis arise and put an end to life. The condition is so miserable that there are few patients who will not submit to an operation for relief, and the results of modern operations are increasingly encouraging, though sometimes several operations are required before cure is complete.

Treatment.

The increase of pelvic operations in the female in the last thirty years has led to an increase in the incidence of these fistulæ, and to the invention of many ingenious devices for their cure.

The surgeon never knows at what moment he may be faced with the problem of a cut ureter, and success in treatment depends more on the immediate measures adopted than on anything else.

(1) *A partial longitudinal wound* should be stitched up with a

single row of fine catgut sutures, and a drainage-tube led from the site of the sutures to the outside of the wound.

Some authors advise stitching up the longitudinal wound transversely, after the manner of a pyloroplasty, with the idea of preventing a stricture, but the first method in clean cases, if carefully carried out, yields rapid healing and no tendency to stricture.

If the state of the patient does not seem to warrant such a lengthening of the operation, the ureter can be left alone and a large drainage-tube led out from it to the surface. In a clean wound healing occurs in a few days, and the ureter gives no further trouble.

(2) If a clamp or ligature has been placed on the ureter, and the fact is noticed before the end of the operation, the ligature or clamp is removed and a large drainage-tube placed in the wound. If gangrene of the ureter should occur a ready exit is provided for the urine, and there is no fear for the patient's life. In favourable cases the wall of the ureter will recover its vitality and no fistula result.

If the ureter has been cut across completely the old methods of primary nephrectomy or ligaturing both ends should never be adopted. If the operation has been a long one, and it is thought that the patient will not stand an extra twenty minutes, the ends of the ureter should be stitched into the vaginal or skin wound and left to be repaired at a second operation; otherwise the ureter should be repaired by the method of Bovée or of Van Hook.

(3) *Cysto-ureterotresis.*

This should be reserved for cases where the wound of the ureter is deep down in the pelvic portion, and such a length of the tube has been destroyed as to make it impossible to bring the two ends together.

CHAPTER V.

INJURIES OF THE URETER.

INJURIES of the ureter are:

1. Subcutaneous.
2. Penetrating.
3. Accidents during surgical operations and especially gynæcological manipulations.

1. Subcutaneous.

Such wounds are exceedingly rare, and it is almost impossible to make a diagnosis from ruptured kidney except by open exploration. They occur in young persons from violent compression of the loin, the wound being partial or complete. The peritoneum is hardly ever torn, but the kidney and gut may be ruptured at the same time. The symptoms are those of shock, with signs of bruising and tenderness over the affected loin, and hæmaturia. A tumour develops in the loin sooner or later, but it does not necessarily appear for months or even years. The swelling, if appearing early, consists of blood-clot, serum, and possibly urine and pus. If appearing after months or years it may prove to be a hydronephrosis secondary to a stricture that has formed at the site of healing.

The disease is seldom fatal unless the peritoneum be involved.

The treatment resembles that for ruptured kidney, for which the disease is generally mistaken. Expectant measures may be safely adopted for a time, but exploration is required if there are signs of involvement of the peritoneum, or if a tumour forms in the loin, or if there is anuria. The loin is opened from behind, blood-clot and urine cleared out, and the extent of the damage determined. The peritoneum, if involved, is cleaned out with dry sponges and drained. The ureter is repaired with fine catgut sutures by simple suture or by the methods of Bovée or Van Hook. In partial wounds suture is not an absolute necessity, and mere drainage will suffice to effect complete healing, but it is better to use sutures whenever it is feasible. If it is found impossible to suture the

ureter at the time it had better be left alone in the wound and a drainage-tube led from both ends to the surface. Efforts can be made at a later date to fill in the gap by means of ureteric grafting.

If a persistent fistula is left or if the kidney becomes infected, a secondary nephrectomy may be required at a later date.

2. Penetrating Wounds.

These are hardly ever met with.

There is evidence of a bullet- or stab-wound in the region of the ureter, and urine escapes by the wound or is extravasated into the tissues.

Such a wound is treated on general surgical principles, which demand immediate exploration of the wound, carried out deliberately under a general anæsthetic, whereby a complete diagnosis is made. The wound is surrounded by a four-inch incision and explored layer by layer till the farthest depths are exposed. The track is thoroughly scrubbed out with strong antiseptics such as 1:20 aqueous carbolic or 1:500 biniodide of mercury, or excised altogether. The divided ureter is repaired with catgut, a drainage-tube inserted, and the rest of the wound closed layer by layer.

CHAPTER VI.

TUMOURS OF THE URETER.

TUMOURS of the ureter are exceedingly rare, and when they do occur they are usually secondary implantations of tumour-cells carried down in the urine stream from papillomata of the renal pelvis, or tumours of the parenchyma.

Primary Epithelial Tumours.

1. *Papillomata* have been reported and are similar in all respects to papillomata of the bladder. They tend to recur locally after removal, and more often than not are malignant. They may give rise to multiple secondary implantation papillomata on the walls of the bladder, and to metastatic deposits in the viscera.

2. *Squamous-cell carcinoma,* with or without cell-nests, may occur as a papillated sessile growth or as a malignant ulcer, usually at the site of a chronic ulcer and stricture produced by an impacted calculus, or in the seat of a patch of leucoplakia, a condition sometimes found in dilated infected ureters above some long-standing cause of obstruction.

Primary Connective-tissue Tumours.

Sarcomata of the walls of the ureter have been reported in two or three instances, for instance a round-cell sarcoma by Targett, and a rhabdomyoma by Ribbert.

Secondary changes.—The tumour blocks the ureter and sets up a condition of hydronephrosis and pyonephrosis in the corresponding kidney. Metastasis may occur by the urine stream, by the lymphatics to the lumbar lymphatic glands, and by the blood-vessels to the liver, lungs, and other viscera.

The onset symptom is *hæmaturia,* which is found by the cystoscope to proceed from one ureter, but it is soon reinforced by symptoms of renal colic and intermittent hydronephrosis on the affected side.

Examination will reveal a tender enlarged kidney, and the ureter may sometimes be felt thickened in its abdominal or pelvic course. The urine may be clear, or contain blood, and later pus.

The X rays may show a ureteric calculus.

With the cystoscope blood may be seen issuing from the affected ureter, and sometimes the growth may be seen projecting from the mouth of the ureter as a villous growth or a smooth, rounded, cherry-like body.

Two difficulties arise in diagnosis:

First, the surgeon cannot be sure whether he is dealing with a primary ureteric tumour or a secondary deposit with a primary focus in the enlarged kidney; secondly, if there are papillomata on the wall of the bladder he may miss the primary focus in the ureter.

The prognosis is bad, as it is seldom possible to make a diagnosis early enough for effective operation, life being cut short by local recurrence and general metastases or from pyonephrosis.

SECTION III.

DISEASES OF THE BLADDER.

CHAPTER I.

RUPTURE OF THE BLADDER.

RUPTURE may be (1) spontaneous, (2) from external violence, (3) from internal violence.

1. *Spontaneous rupture* occurs under two conditions:

(*a*) When the wall of the bladder is softened by disease so that it can no longer resist the normal intra-vesical tension, such as is seen in gangrenous cystitis or after pressure ulceration caused by a drainage-tube badly placed or too long retained.

(*b*) When the wall of the bladder is thinned and herniated by back-pressure, and cannot resist the raised intra-vesical tension.

2. *External violence* can only cause rupture when the bladder is full. In one variety a drunken man with a full bladder receives a kick or a punch from a comrade just across the pubes; in another variety the whole pelvis is submitted to a crushing force and the ruptured bladder is a complication of fractured pelvis.

3. *Internal violence.*—The bladder has been ruptured by forcible over-distension in the course of lavage or during the evacuation of a stone, or even by the point of a metal catheter or sound. This can only occur in children or in old people with thinned bladders, which should always be treated with the utmost gentleness, or when the walls of the bladder are gangrenous from disease.

Pathology.

The site of the rupture is on the posterior wall, and involves the peritoneum (*intra-peritoneal* rupture) in 80 per cent. of

the cases, whereas in 20 per cent. it is *extra-peritoneal* into the pelvic cellular tissues, and involves the anterior surface of the neck of the bladder.

Extravasation of urine and blood takes place into the peritoneum, or into the pelvic cellular tissues. In one case the peritoneum fills rapidly with free fluid; in the other the fluid makes its way into the retroperitoneal tissues upwards and forwards into the inguinal regions, backwards around the rectum, and then upwards along the ureters into the perirenal pouches.

If the urine is healthy and contains no bacteria peritonitis and cellulitis do not necessarily occur, as has been proved both clinically and by experiments on animals; but in the majority of cases the urine so damages the tissues that bacteria make their way into them either from the gut direct (*Staphylococcus albus, Bacillus coli*), from the blood, or from the kidney, and in forty-eight hours or so a violent peritonitis or cellulitis is set up, which gives rise to septicæmia and death. If the urine be already infected at the time of the accident the onset of fatal inflammation is even more rapid.

Symptoms, Diagnosis, and Treatment.

Symptoms that should lead the practitioner to suspect a ruptured bladder:

1. A history of violence applied to the pelvic region.
2. Signs of bruising, excoriation and extravasation of blood in the pelvic region, and of fractured pelvis.
3. Signs of serious shock.
4. Inability to pass water after such an injury, or the passage of blood-stained urine.

If ruptured bladder be suspected, no time should be lost to confirm the diagnosis and carry out suitable treatment at a single sitting, the best way being to administer 0·6 c.c. of stovaine (Billon) into the spinal sheath; but failing this, a large dose of morphia should be given (gr. $\frac{1}{3}$–$\frac{1}{2}$), and anæsthesia be completed by the exhibition of ether. Meanwhile, preparation for examination and operation has been made, and the patient is laid on the operating table.

The surgeon begins with palpation of the loins, the hypogastrium, the perinæum and the rectum for signs of extravasation of fluid, reinforced where feasible by percussion.

The line of the liver dulness is marked out in blue, and the circumference of the belly at the umbilicus measured. A soft rubber catheter (Jacques No. 10, English scale) is then

passed with full antiseptic ritual. In intra-peritoneal rupture the bladder is empty, and nothing but a little blood is drawn off; in extra-peritoneal rupture the bladder is not empty, and a certain amount of urine and much blood is found. A Higginson's syringe is attached to the mouth of the catheter and air is pumped into the bladder, after which a fresh examination is made of the liver dulness, the circumference of the belly, and for surgical emphysema above the pubes, or *per rectum*.

By the employment of this method an immediate and correct diagnosis cannot fail to be made. If there is no rupture the air is expressed and the bladder washed out with boracic lotion. If there is a rupture no treatment is of any avail except immediate exposure and suture of the rent, and the earlier this is done the lower the mortality. Expectant treatment is almost invariably fatal (over 90 per cent.). Early operation yields brilliant results (mortality 14 per cent., or less in cases obtained early).

Operation.

The operation must be carried out forthwith as soon as the diagnosis has been made, with the patient in the Trendelenberg position. A free median supra-pubic incision gives access to the damaged structures, the peritoneum being freely opened if it is known to be wounded, and the intestines packed off with flat sponges or gauze pads. The rent is exposed and united with a double row of *catgut* stitches, the first row being buried by the second applied mattress-wise. The bladder is distended with water to see that the junction is water-tight, after which a toilet of the peritoneum is carried out by means of dry sponges on holders, though no harm can come from washing out the peritoneum with salt solution at this stage. The peritoneum is stitched up without a drainage-tube. The bladder can be drained with an extra-peritoneal stab wound in the front wall or by a large catheter tied into the urethra, and a tube must always be left in the cavum Retzii.

In cases of extra-peritoneal extravasation the rent should be united if possible, but if it is impossible it can be left alone. In either case adequate drainage must be provided for the pelvic cellular tissues. A counter-opening can be made into the perinæum and an eyed tube brought right through by the side of the urethra and rectum, and another tube inserted leading from the supra-pubic incision to the

neck of the bladder. Irrigation of the tubes should be performed at least twice daily till the fourth day, when the tubes can be removed altogether and the wounds allowed to close.

FOREIGN BODIES IN THE BLADDER.

An endless variety of strange objects have been found in the bladder, and in nine cases out of ten the objects have been introduced by way of the urethra. The following is a list of the possible sources of such foreign bodies with examples of each:

(1) *Per urethram*—broken catheters, hair pins, pipe-stems, slate pencils, glass rods, straws, hat-pins, wax tapers, corks, etc.

(2) *By the ureter*—hydatid cyst, silk stitches, (stones).

(3) *From the intestine*—pins, fæcal matter, etc.

(4) *Bone disease*—sequestra.

(5) *From the skin*—bullets, pins, and through fistulous wounds, gauze, tubes, etc.

(6) *Ulceration of a pelvic dermoid*—hair, etc.

These bodies are usually long and smooth, but they may be short and rounded, sharp or blunt, irregular, hard or soft, flexible or friable, and are more often encountered in women than in men.

If small and smooth they may give rise to no pathological change or symptom for a long time; but in the majority of instances they induce a severe cystitis, and becoming encrusted with phosphates rapidly form a stone. Rarely they produce ulceration or even penetrate the walls of the bladder, and set up a pelvic cellulitis or peritonitis.

The diagnosis is clear if an honest history can be obtained, but generally speaking not only do these patients fail to tell the doctor anything, but even after the foreign body has been successfully extracted they may deny any previous knowledge of it.

The symptoms are those of a severe cystitis accompanied or not by hæmaturia at the end of micturition, and the diagnosis has to be made from the other common causes of cystitis, especially tuberculosis and stone. In the absence of the tubercle bacillus in the urine, cystoscopy is performed and at once reveals the cause of the trouble in an early case; but in late cases the foreign body may be so buried in phosphates that it is taken for a primary phosphatic-covered stone in the absence of a true history. Attempts to crush

such a stone may end in failure if the nucleus is such a body as a bit of a gum-elastic catheter.

A radiogram will often show clearly the outline of the foreign body.

Treatment.

Spontaneous expulsion is a rare event, either into the bowel or on to the skin, or by way of the urethra. At other times the body enters the urethra and becomes impacted, leading to a violent and disastrous urethritis and pelvic cellulitis. Extraction by surgical methods at the earliest possible moment yields the most encouraging results. With the patient under general anæsthesia a cystoscope is passed to reveal the nature, size, shape and position of the object, and to make certain that it is not firmly fixed in the bladder-wall. Some bodies will be found fixed just above the trigone, others float to the top of the bladder in the most provoking fashion. In suitable cases a lithotrite is passed and is made to grasp one end of the object, which can then be brought into the urethra and pressed out from thence.

If the cystitis is too severe, or if the object cannot be grasped, if it is of unsuitable shape or surface, if it is too friable, and finally, if it is firmly embedded in the wall of the bladder, supra-pubic cystotomy had better be performed, the whole of the foreign material extracted, and the wall of the bladder inspected and repaired. Not a little of the value of such an operation is the opportunity it affords for supra-pubic drainage.

CHAPTER II.

VESICAL CALCULUS.

Ætiology.

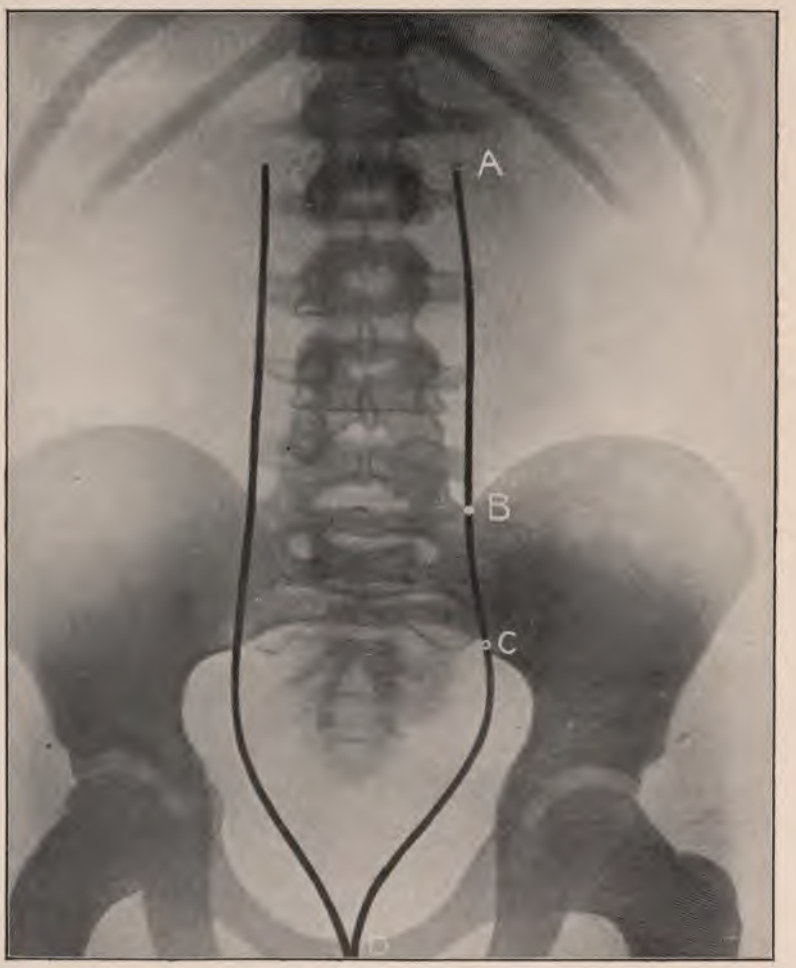
A VESICAL calculus may be formed in the kidney and descend to the bladder or it may be formed in the bladder itself. Calculi are called primary when the actual cause is unknown, secondary when the cause is microbic infection of the bladder. Primary calculi are formed in acid urine, secondary in alkaline and ammoniacal urine.

PRIMARY CALCULUS.—The exciting causes are unknown. The predisposing causes are general and local. The general causes are discussed in Ch. V, Sect. I. The local predisposing cause is *stagnation of urine.* The stagnant pool of residual urine that lurks behind an adenomatous prostate in a gouty old man often remains free from infection for years owing to the highly acid nature of the urine. Uric acid tends to be deposited in highly acid urines, and in this way a large, laminated, reddish-brown stone composed of little else but urates and pigments may form quietly behind an enlarged prostate. The stone is fixed in the post-prostatic pouch so that it is *painless*; it is in highly acid urine, so that it remains *pure and aseptic*; it is composed of urates, so that it *does not show on the X-ray plate,* and from its position *it is missed by the sound.*

The stagnant urine in an acquired diverticulum of the bladder in the same class of case likewise predisposes to calculus.

Primary vesical calculi are uncommon except in children and old men. In children they descend from the kidney, the nucleus being a relic of the uratic sand present at birth. In old men they arise as a secondary result of uric acid gravel and an enlarged prostate.

SECONDARY CALCULUS.—Secondary calculi are produced by the action of bacteria, which decomposes the urine and leads to a deposit of triple phosphates around the products of catarrh. Bacteria may reach the bladder by descent from the kidneys, from the blood direct, or be carried in from the urethra (see



Diagrammatic divisions of the radiographic shadow of the ureter.

Ch. III, Sect. III). The predisposing causes are stagnation of urine, the entry of foreign bodies, and damage to the bladder-wall. The common causes of stagnation of urine are enlargements of the prostate, stricture of the urethra, and nervous disease. The common foreign bodies met with are pre-existing primary calculi, tumours, organic *débris* of ulcers and cystitis, parasites, and miscellaneous foreign bodies introduced by way of the urethra, such as broken catheters, hair-pins, tapers, etc.

In other words, the causes of secondary calculus are the same as those of chronic cystitis (see Ch. III, Sect. III).

Secondary calculi are of far less frequent occurrence than in former times owing to the improved methods of preventing and curing cystitis, and are only met with nowadays in neglected cases of stricture and adenomatous prostate, and in cases of chronic cysto-pyelitis.

Pathology.

The structure of calculi, their composition and appearances, have already been discussed in Ch. V, Sect. I. The nucleus may be a primary renal urate or oxalate stone, or else a foreign body such as a broken catheter, a hair-pin, blood-clot, a slough, a parasite, a portion of a tumour, etc. The size and weight vary greatly, stones weighing two or three pounds having been reported, and as many as 1000 having been present at one time. The shape depends on the composition of the stone; for instance a uric acid stone is smooth and ovoid, an oxalate rough and spiculated; or on the position of the stone, which may be facetted by neighbouring stones, or moulded by the walls of the bladder. Stones that arise in pouches may present an accurate cast of the shape of the pouch, or may resemble a dumb-bell, the constriction being caused by the narrow neck of the pouch.

Spontaneous fracture is a rare event, but happens occasionally. It seems to be produced by a physical change wrought in the organic framework of the stone by the low density of the urine under the influence of diuretic waters, and is certainly not a process of solution by chemical action. Its occurrence is so rare as not to be worth counting upon, and presents far more pain and risk than surgical fracture.

The stone usually lies completely in the bladder and is free to move; but less commonly it is adherent to an ulcer, or is fixed behind the prostate by the bladder-walls.

When a bladder pouch is present a stone is almost certain to form within it sooner or later. Pouches are acquired or

congenital. The acquired arise in hypertrophied bladders acting against urethral obstruction, and are herniæ of the mucous membrane between the interlacing muscle-bundles. They are often multiple, and cystitis is a common accompaniment. Congenital pouches are less common, are usually single, lie near the mouths of the ureters, and are known by the fact that no hypertrophy or trabeculation of the bladder-muscle can be seen.

Even apart from urethral obstruction, the irritation caused by the stone may lead to hypertrophy of the bladder-muscle from the increased frequency of micturition. The bladder-wall in the region of the stone is red and swollen, and when cystitis has occurred the whole bladder-wall will appear inflamed, and be covered with phosphatic *débris*, and may exhibit ulceration.

Ascending pyelitis and pyelonephritis are late complications in neglected cases.

Symptoms and Signs.

Pain is seldom absent except in old men with adenomatous prostates and clean bladders, in which the stone is fixed in the post-prostatic pouch, or the walls of which are atonic and cannot pass into painful cramps. The pain is brought on and made worse by movement, and relieved by rest, any kind of jolting or sudden movement sufficing to precipitate an attack. The pain is felt towards the end of the act of micturition, and passes off in a few minutes, being a severe cramping pain felt either at the end of the penis, at the scroto-perinæal junction, or deep in the neck of the bladder.

In children the pain is very acute and is revealed by the screams of the child during micturition. The child catches hold of the foreskin and pulls at it trying to relieve the pain.

When cystitis is added an aching pain in the hypogastrium is felt apart from micturition and the penile pain is increased.

Pain spreading down the thighs or into the sacrum or into the lumbar regions suggests either the presence of other stones in the kidney and ureter or the presence of accompanying malignant disease of the bladder or prostate.

The stream.—Sudden stoppage of the stream during micturition is highly suggestive of stone in children, but in adults it is far more often due to a papilloma or to nervous disease, and in old men to enlargement of the prostate.

Complete retention of urine may occur in children from the impaction of calculus in the urethra, but is almost unknown in adults. This is accounted for by the fact that the calibre of the ureter is larger than that of the urethra in children, whereas in adults it is smaller. A renal stone that can get through the ureter in adults can usually be passed through the urethra without causing retention.

True incontinence is set up very rarely by the impaction of an irregularly shaped stone in the prostatic urethra.

Frequency of micturition is much increased in the day-time while the patient is up and about, but ceases at night as soon as he lies down to rest. When cystitis is added the frequency is increased both by night and by day.

Hæmaturia.—Next to pain and increased frequency of micturition hæmaturia is the most common symptom, but it is often absent. Like the pain it is brought on and made worse by movement, and soon ceases if the patient rests in bed for a few hours, though microscopic quantities of blood are seldom absent for very long. The blood is bright red, and generally appears at the end of micturition; but at times it colours the urine diffusely and appears in as great quantities in the urine first passed as in the last. In such a case the urine may be smoky, and the patient may not know that blood has been passed.

Physical Signs.

The urine may be quite clear to the naked eye even a few hours after an attack of stone, so that although the urine contains nothing abnormal there may yet be a large stone in the bladder. Crystals of uric acid or calcium oxalate are often found in the fresh urine when it is acid, and crystals of stellar or triple phosphates when it is alkaline or ammoniacal. Though the mere passage of crystals in the urine may cause all the symptoms of stone, yet the persistent finding of crystals in the urine immediately it is passed day after day is highly suggestive of stone.

With the microscope red blood-corpuscles may be found apart from evident hæmaturia, and pus cells and epithelial cells are seen when cystitis supervenes.

Rectal, vaginal and bimanual examination, with or without the administration of an anæsthetic, often enables the stone to be felt between the fingers. In children it is seldom that the diagnosis cannot at once be clinched in this manner, which saves the risk of sounding or cystoscopy and renders

an X-ray examination needless. In female children the tiny hard uterus feels very like a stone in the base of the bladder, so that its presence should not be forgotten.

The Cystoscope.

This has replaced the sound almost completely. There is nothing that can be determined by the sound that cannot be determined more accurately by the cystoscope, and in addition. the exact shape, size, position, number, and colour of the stones can be determined by direct vision, and the presence of pouches containing stones and complications such as intra-vesical projection of adenomatous prostate, primary bladder tumour, and other diseases of the bladder can be detected or excluded.

The sound does more damage to the wall of the bladder and so may more readily set up infective cystitis, and it may give rise to a false idea that a stone is present when there is only a phosphate-covered ulcer.

Sometimes in small children it may be necessary to use the sound, but the stone can usually be detected by bimanual rectal examination.

The cystoscope should never be used during "an attack of stone." The patient is put to bed for twenty-four to forty-eight hours and given urotropin and large potations of some diuretic water, when the urine will rapidly become clear, often in twelve hours, and cystoscopy can be performed in the patient's own urine.

The Sound.

Precautions in sounding.—(1) Never sound during an attack of stone. (2) Reduce the irritation and inflammation of the bladder by a short rest in bed, diuresis, and drugs. (3) The patient is placed on his back with a sand-bag under the pelvis, the object being to tilt the bladder so that the stone falls away from the base. The urethra is irrigated with a weak antiseptic lotion, a sterilised catheter is passed, the bladder emptied, and a measured quantity of boracic solution (six ounces) injected with a syringe. The sound is passed and is made to explore all parts of the bladder systematically, the greatest gentleness being used to avoid bruising the bladder-wall. The stone is felt and heard, and a rough idea may be obtained of its surface, size, and shape, from which its colour and constituent salts can often be correctly guessed. A sound may fail to detect a stone because the stone is buried

in the œdematous bladder-wall, is hidden in a pouch, or is lodged in the upper half of the bladder.

A lithotrite can be used for purposes of diagnosis instead of a sound and the diameters of the stone accurately measured.

Digital exploration of the bladder can be carried out in females after dilatation of the urethra with Hegar's dilators up to No. 17 on the scale, but it is a procedure that is rarely required and has little to recommend it.

Exploration by operation, perinæal, supra-pubic or vaginal, is seldom carried out at the present day merely for diagnostic purposes.

X-Ray Examination.

Owing to the cystoscope this plays a minor *rôle* in the diagnosis of stones in the bladder, though it should never be omitted in the routine examination, as *many stones in the bladder are accompanied by multiple stones in one or both kidneys.* It is no use clearing the bladder if a gravel pit be left behind in the kidney uncleared.

Pure uratic stones are more common in the bladder than in the kidney, and such stones may fail to cast a shadow on the plate. Again, just as in the kidney, certain large secondary phosphatic stones lying in an acutely inflamed bladder may throw a very poor shadow.

Course and Prognosis.

Spontaneous expulsion of a vesical calculus is uncommon even in women if renal calculi that pass straight through the bladder are excluded. Spontaneous fracture and discharge of the fragments after a prolonged course of Contrexeville water is a still rarer phenomenon, and in most cases little short of surgical procedure suffices to remove the stone. Cystitis secondary to the stone is by no means always present, but arises sooner or later after months or even years. Impaction of the stone at the neck of the bladder, with true incontinence of urine, sometimes occur, and in children complete retention is produced by urethral impaction. Pyelo-nephritis arises sooner or later, especially if the kidneys have already been damaged by back-pressure. In such cases the prognosis is far from favourable, and the risks of lithotrity are by no means to be minimised, though the chances are much improved if the patient be put to bed for a week beforehand and drenched internally with water and urinary antiseptics.

Apart from these complications, the prognosis is excellent with early diagnosis and early treatment.

Differential Diagnosis.

Certain *infiltrating carcinomata of the bladder and prostate,* and certain cases of *enlarged prostate* presenting both pain and hæmaturia, may simulate the symptoms of stone, but rectal examination and the cystoscope settle the question at once. The same is true of cases of *Bilharzia hæmatobia* of the bladder when the cystitis is at all severe, but the history and the cystoscopic picture are characteristic.

The onset of *acute posterior urethritis* (gonorrhœal) is sometimes a source of error. The discharge from the anterior urethra may cease abruptly *and entirely,* while the patient complains of intense pain in the neck of the bladder or at the end of the penis, passes water frequently, and may pass blood at the end of micturition. The urine contains pus and threads. Knowledge of these facts, and an accurate history, should be sufficient to keep the practitioner on the right track. Sounding under such conditions will lead to prostatitis and epididymitis at the very least and may induce cystitis and pyelitis.

The onset of *tuberculous cystitis* may simulate that of stone, but hæmaturia is not at all common as an onset symptom in tuberculosis of the bladder, and the pain bears no definite relation to movement; hæmaturia is seldom repeated, pus is present in large amounts, the frequency of micturition is increased at night as well as by day, and in some cases the presence of tubercular nodules elsewhere, as in the epididymis or lungs, may point the way clearly. The finding of the tubercle bacillus clinches the diagnosis. Stone is not common at the present day in young men, so that a youth who describes the symptoms of stone is more likely to be suffering from acute posterior urethritis or tuberculous cystitis.

Golden Rule.—Do not sound in a young man till you have excluded the gonococcus and the tubercle bacillus.

In children stone is common, but the symptoms can be completely simulated by *Bacillus coli* cysto-pyelitis, by phimosis, and by the mere passage of crystals. Hæmaturia, pyuria, bladder-spasm and incontinence of urine can all be produced in children by an infection of the urinary tract with the colon bacillus, the main symptoms and signs of which may disappear in a few hours with rest in bed and free diuresis.

Phimosis is so common in children that it is not wise to treat the symptoms of stone by circumcision, and then wait

to see if the symptoms disappear. Stone can most easily be excluded by rectal bimanual examination.

Treatment.

Treatment is preventive and operative.

1. Preventive.

A. *General* (see Ch. V, Sect. I).

B. *Local.* This consists in remedying predisposing conditions before they can give rise to stone. The dilatation or incision of strictures, the enucleation of adenomatous prostates, the prevention of cystitis (see Ch. III, Sect. III), the immediate removal of foreign bodies are the main measures which in the last twenty years have greatly reduced the incidence of vesical calculus.

2. Operative.

Crushing or *cutting* operations can be performed.

Lithotrity was the term applied to the crushing of a stone, the fragments being left to pass naturally. This process was replaced by *litholapaxy*, where, after the stone has been crushed, it is at once removed by the evacuator of Bigelow. *Perinæal litholapaxy* is the term applied when the operation of crushing is performed through a perinæal urethrotomy wound.

Lithotomy is the term applied to the operation of cutting for stone. Lateral, median, and vaginal perinæal lithotomy have been completely replaced by supra-pubic lithotomy; as the mortality is less, larger stones can be removed, first intention healing can often be obtained, and there is no risk of subsequent incontinence and sterility.

The choice of the surgeon, therefore, lies between litholapaxy and supra-pubic lithotomy, except in females, when small stones may occasionally be removed through the dilated urethra.

Litholapaxy is preferred, with a few exceptions, for the following reasons: (1) The mortality is not more than 3 per cent. (Desnos, 1998 cases, mortality 2·75 per cent.; Watson, 17,736 cases, mortality 2·4 per cent.), whereas the mortality of supra-pubic lithotomy is much higher (Watson, 3303 cases, mortality 13·2 per cent.). (2) The stay in bed is not more than a few days as opposed to three weeks in the

case of lithotomy. (3) There is no wound left to heal up, and so no risk of fistula, cellulitis, etc.

The objections that can be urged against it are: (1) That recurrence of stone is more common after litholapaxy, as fragments may get left behind. *This is not so if the cystoscope be used to make sure that the bladder is empty.* (2) That it is a more difficult operation and takes a longer time.

The dangers and difficulties of lithotrity: (1) In atonic bladders the walls tend to flap in between the blades and might get crushed. (2) Clogging of the blades of the lithotrite. This does not happen if the lithotrite is fenestrated. (3) Breaking of the lithotrite. A lithotrite made by a reliable maker will not break. (4) Hæmorrhage, cystitis, prostatitis, epididymitis, ascending pyelonephritis. (5) Stricture of the urethra. This must be cut or dilated previous to the operation.

Contra-indications to Litholapaxy and Indications for Supra-pubic Lithotomy.

1. *In old men with enlarged prostate,* in whom better treatment is supra-pubic lithotomy with drainage followed by supra-pubic prostatectomy after ten days or so.
2. *A pouched stone.*
3. *An adherent stone.*
4. *If the stone is too large* to be grasped between the blades of the lithotrite.
5. *If the stone is too hard* to be crushed.
6. *If a foreign body forms the nucleus* which cannot be crushed or grasped and manipulated through the urethra.
7. *Children under three years of age,* or if the surgeon is not expert with the lithotrite under ten years of age.

After supra-pubic cystotomy, if the urine is clean and little damage has been done to the edge of the wound, it is best to unite the edges of the wound completely, as healing by first intention will often be obtained.

In children it is possible to perform litholapaxy from the age of three years and upwards, and it has been performed even in younger children (Keegan). The surgeon should be expert in crushing stones in adults as the parts in children are more delicate and more liable to injury. Keegan states that children from three to six years can take a No. 7 or 8 lithotrite and tube of the English scale if the meatus be cut; children of eight to ten years, No. 10 to 14 of the English

scale. If too much fluid be injected into the bladder there is a risk of rupturing the thin bladder-wall if the evacuator bulb be squeezed too forcibly and roughly.

Supra-pubic lithotomy had better be performed in children if the surgeon feels he is inexperienced in litholapaxy, and if the stone is at all large or hard. The bladder is more easily reached by that route in children, and the after-risks are very slight.

In Women.

1. Dilatation of the urethra with immediate extraction can be performed in the case of small stones.
2. Failing this, litholapaxy is the operation of choice.
3. Supra-pubic lithotomy may be required for very large, hard stones. Vaginal lithotomy should not be performed as the risk of fistula is too great.

A Pouched or Encysted Stone.

It is unwise to attempt to crush such a stone.

Supra-pubic cystotomy should be performed and the pouch explored.

It may be possible to extract the stone from the pouch, the mouth of the pouch having been nicked, or to crush it *in situ* and extract the fragments.

Failing this the stone may be steadied by a finger in the rectum, and broken into several fragments with a chisel and hammer.

Seeing that these pouches are certain to manufacture fresh stones from time to time, it is clear that in suitable cases the best treatment would be to remove them (see below).

DIVERTICULA AND POUCHES OF THE BLADDER.

Definitions.

A *diverticulum* is a sac lined by bladder epithelium, communicating with the bladder by a narrow neck.

A *pouch* is the term applied to an outward bulging of a large area of bladder-wall at a weak spot.

Ætiology.

Diverticula and pouches are acquired or congenital.

Acquired diverticula arise when there is some obstruction to the urinary outflow, most commonly a small intra-

vesical projection of the prostate ("middle lobe"), less commonly a stricture of the urethra. Hypertrophy of the trabeculated inner layer of muscular fibres occurs, and the mucous membrane of the bladder is forced out between the trabeculæ, so that herniæ of the bladder are formed, which continue to grow outwards and may attain a large size. These herniæ tend to arise at certain spots, namely, on the lateral walls just outside the ureters and high up on the posterior wall. *Pouchings* appear from similar causes just behind the inter-ureteric bar, "the post-prostatic pouch," and occasionally on each side of the trigone. Acquired diverticula are usually multiple.

Congenital diverticula appear in young males in whom there is no evidence of urethral obstruction. They are usually single, and arise above and to the outer side of the ureter, or at the apex of the bladder where the urachus is attached. They are germinal sports.

Structure.

The mouths of diverticula are seldom more than half an inch in diameter, and may be so small as to be hardly visible; they may possess valves. The sac is lined from within outwards by bladder epithelium, submucous tissue, a delicate layer of muscular fibres, subperitoneal tissue, and fat. According to Englisch the congenital diverticula possess no muscular coat, but Young found this coat represented in all his cases. At the same time this muscle layer is extremely feeble, and seems incapable of emptying the sac completely. The walls are thin, and shell out readily from the surrounding tissues; but when infection has arisen the walls become thickened and sclerosed, and adherent to the surrounding structures. In congenital cases other sports are frequently present in the kidney, ureter, or urethra, or in other parts of the body.

COMPLICATIONS arise from pressure and from infection.

1. *Pressure.*—As the sac grows larger it displaces and presses upon the structures in its neighbourhood, so that the ureter may become displaced, kinked, and obstructed, the urethra blocked by elevation of the trigone, and even the blood-vessels be pressed upon. One or both kidneys may become dilated, and the kidney substance destroyed.

2. *Infection.*—Owing to stagnation of the urine in the diverticulum, and the necessity that so often arises for regular catheterisation, infection, ascending or descending, is bound to

occur sooner or later. Chronic cystitis cannot be controlled in a diverticulum, and secondary calculi quickly form. The wall being thin, the inflammation may spread through the walls of the sac, setting up pericystitis, perivesical abscess, and peritonitis. Ascending pyelonephritis is seldom long delayed owing to the back-pressure on one or both kidneys.

Symptoms.

Many diverticula lie latent, and are only discovered at autopsy, or at a routine cystoscopy. Most often the patient presents symptoms that point to an adenomatous prostate. combined with a calculus, and the diverticula are found by cystoscopy or at operation. In young males the symptoms are very puzzling.

In one class of case the patient complains that he passes water too frequently day and night. A large amount of residual urine is discovered, though there is no urethral obstruction. Regular catheterisation once a day relieves the symptoms of increased frequency. The condition is discovered by the cystoscope. The symptoms are set up by the inability of a large, thin-walled diverticulum to empty itself.

In another class a *phantom tumour* appears in the abdomen from time to time with a feeling of painful distension. The tumour disappears suddenly, accompanied by the passage of an unusual amount of urine, or in response to catheterisation. It is not known why the mouth should thus become blocked from time to time. A valvular arrangement or an attack of inflammatory swelling of the mouth might account for it.

Pressure symptoms.—The diverticulum may raise the floor of the trigone and obstruct the urethra, the symptoms being those of incomplete retention of urine and back-pressure on both kidneys, and finally, those of uræmia; or it may press upon one ureter leading to signs of unilateral hydronephrosis.

Signs of infection and inflammation.—There may be the symptoms of general cystitis—acute and chronic—of vesical calculus, or of intermittent painful abdominal tumour, which disappears simultaneously with a large discharge of purulent urine. Finally the symptoms of pyelonephritis may supervene.

Diagnosis.

The diagnosis may be suspected from the history, but it is not usually confirmed until cystoscopy is carried out in the routine examination of an obscure urinary case.

The appearance of a diverticulum is characteristic. In acquired cases there is advanced trabeculation and the diverticula are multiple. In congenital cases there is no trabeculation unless the diverticulum has itself obstructed the urethra.

Differential Diagnosis between Congenital and Acquired Diverticula.

Congenital.	Acquired.
Young men.	Old men.
Single.	Multiple.
No trabeculation.	Trabeculation.
No urethral obstruction.	"Enlarged prostate," "median lobe."
Other abnormalities common.	No other abnormalities.
Above and to outer side of ureter and at the apex.	Posterior and lateral walls, high up.
No pouching.	*Pouching* of inferior posterior and lateral walls.

Treatment.

The treatment of congenital cases is a difficult problem.

If there are no symptoms and the condition has been discovered accidentally, it is probably better to leave it alone. At the same time symptoms are bound to arise sooner or later and the condition will eventually cause death, so that an operation can be advised with ample justification. Some patients discover for themselves that a catheter passed regularly once or twice a day will relieve their increased desire to micturate, but the dangers of infection and the fact that these patients are usually young men should influence the surgeon and lead him to advise exploration and excision.

If cystitis appears it is impossible to cure it by antiseptics and lavage, and a calculus is bound to arise. The calculus needs to be attacked by supra-pubic cystotomy and can often be removed by nicking the neck of the sac, or by crushing it *in situ* either with a lithotrite, or a chisel and mallet, the stone being steadied by a finger in the rectum. Seeing that the calculus is bound to re-form the patient should be advised to undergo an operation for removal of the sac if it is in an accessible position and the general strength of the patient seems to warrant it.

Efforts have been made in the past to cure the condition by stretching or incising the mouth of the sac, or by curettage and obliteration by purse-string sutures. These methods are not satisfactory.

Where the patient's kidneys have not been extensively destroyed by back - pressure or suppuration a determined effort should be made to remove the diverticulum by operation, especially if the sacculus is causing obstruction or has become infected. In infected cases a preliminary supra-pubic cystotomy should be carried out with drainage and lavage for ten days. The operation can be performed by supra-pubic exposure of the bladder, either extra- or intra-peritoneally. Intra-vesical enucleation has been carried out successfully by Young, but in other cases it is necessary to dissect the sac out carefully from the surrounding structures, and even to excise the lower end of the ureter and implant the upper end into the bladder afresh. The reader is referred to Young's paper for full details and for the literature of the subject ('Johns Hopkins Reports, vol. xiii, 1906, p. 401, *et seq.*).

CHAPTER III.

INFLAMMATION OF THE BLADDER; CYSTITIS.

Ætiology.

INFLAMMATION of the bladder is produced by the direct action of irritants, living or non-living. The causes are exciting and predisposing.

EXCITING CAUSES.

1. *Mechanical irritants :*
   Foreign bodies—instruments—stones—tumours.
2. *Chemical :*
   Inorganic, e.g. ammonia and ammonium carbonate manufactured from urea by bacteria.
   Toxins, e. g. the urine from tuberculous kidneys.
3. *Living :*
   Bacteria, e.g. Bacillus coli, streptococci, staphylococci, proteus, tubercle bacillus, etc.
   Parasites, e. g. Bilharzia hæmatobia.

PREDISPOSING CAUSES.

1. *Trauma* produced by non-living irritants, *e. g.* instruments, stone, tumour, strong caustic injections, sudden acute over-distension, pelvic prolapse, pressure of the pregnant uterus and pelvic tumours, parturition.
2. *Chronic back-pressure* and *residual urine.*
3. *Nervous disease,* local or central, causing diminished trophic resistance of the walls.
4. *Poisons in the blood, e. g.* diabetes.
5. *Excessive alkalinity* of the urine.

If bacteria are absent, cystitis is seldom very acute or prolonged, and resolution occurs rapidly; but if the irritation be severe bacteria quickly make their way to the part, and the inflammation may then be prolonged and obstinate of cure.

Bacteria reach the walls of the bladder by four different routes:

1. *Ascent of the urethra:*
   (*a*) Spontaneous ascent after urethritis.
   (*b*) Carried in by instruments.
2. *Descent from the kidney* (see Ch. VII, Sect. II):
   (*a*) After hæmatogenous infection of the kidney.
   (*b*) By a process of filtration from the blood through the kidney.
3. *Infection of the bladder-wall from the blood, e. g.* primary tuberculosis.
4. *By direct tissue spread* from inflammation of adjacent viscera or surfaces.

The mere presence of bacteria in the bladder urine is not sufficient to set up cystitis.—This has been shown experimentally, and is demonstrated clinically in cases of pyelo-nephritis set up by the colon bacillus or the tubercle bacillus, where the bladder may remain free for years. The bladder-wall, like the skin, is lined by many layers of epithelial cells; it offers a stout resistance to the penetration of organisms into the submucous tissues, and from its essential nature as a reservoir for urine it is designed to oppose absorption. *Another contributing cause must act in combination with the presence of bacteria before these can penetrate the wall and set up inflammation.* Such causes are as follows:

(*a*) *Mechanical bruising* of the wall or breach of epithelium produced by instrumentation, stone, forced over-distension, etc.

(*b*) *The too intense action of caustic solutions* injected into the bladder.

(*c*) *The decomposition products of certain bacteria.*—For instance the *Bacillus proteus* if injected into the bladder decomposes urea into ammonium carbonate and ammonia. The ammonia injures the walls, and the *proteus* can then enter the walls and set up inflammation. If, on the other hand, there be injected the *Bacillus coli* or a streptococcus which cannot split urea, these are powerless by themselves to set up cystitis, and can only cause a transient bacilluria.

(*d*) *The toxins of certain bacteria.*—In similar fashion the soluble extra-cellular toxins produced by certain bacteria may damage the walls and prepare the way for the onslaught of the bacteria themselves. The irritation of the bladder produced by the urine from a tuberculous kidney may be cited as an example.

(*e*) *Residual urine.*—So long as the bladder can empty itself completely at each act of micturition, bacteria in the urine are kept moving on and have no time to set up inflammation. If, owing to an enlarged prostate, a urethral stricture, nervous disease or some other cause the bladder is unable to empty itself completely, a stagnant pool of residual urine is left lying at the base, which forms a veritable culture chamber, or bacterial tank, if from any direction bacteria are enabled to make their way to it, either from below after incautious instrumentation, or from above by way of the kidneys.

(*f*) *If the vital nutrition of the bladder-walls be lowered,* bacteria that in health would be powerless can then advance to the attack. This lowering of resistance is seen in diseases of the nerve supply of the bladder, such as tabes, transverse myelitis, etc.; and also in diabetes, when the sugared blood seems unable to resist bacterial influences.

Experimental Work.

Pasteur discovered that the fermentation and decomposition of the urine set in the air was due to the action of living yeasts.

Bum, quoted by Jungano, isolated a staphylococcus from a case of cystitis, and injecting it into the bladder of a dog found that he produced no result; but having first irritated the mucous membrane mechanically or induced retention of urine before injecting it he found that he could produce cystitis. The same holds good for the colon bacillus (Melchior, Albarran, Hallé).

Schnitzler found that by injecting the *Proteus Hauseri,* which can decompose urea, into an animal's bladder, he could produce a violent cystitis without taking any further steps.

Parascandalo showed experimentally the important *rôle* played by trauma, caustics, toxins, residual urine and lesions of the nervous system in enabling bacteria to attack the bladder-walls.

Bazy and Rovsing and others injected the colon bacillus into the veins of a rabbit's ear, and induced retention of urine for some hours. A *Bacillus coli* cystitis followed.

Jungano ('Le Flore de L'Appareil Urinaire,' 1908) quotes a collection of 304 cases made by Albarran, Hallé and Legrain (1898) to show the relative frequency of occurrence of the

different bacteria found in cases of cystitis (tuberculous cases being excluded).

A colon bacillus was found 111 times, a staphylococcus 70 times, the proteus 27 times, a streptococcus 18 times, the gonococcus 13 times, the typhoid bacillus 5 times, the pneumococcus 3 times, the Bacillus pyocyaneus twice. Other organisms were found on rare occasions but need not be enumerated.

It is doubtful whether the gonococcus would be found so often if efforts were made to separate the secretions of the posterior urethra from the bladder urine. Cystitis caused by the gonococcus itself is less common than the above figures would suggest, the symptoms and signs of posterior urethritis having been mistaken in the past for those of cystitis. At the same time the gonococcus is a most important agent in so altering the state of the urethra that other organisms (streptococci and staphylococci) can ascend the urethra to the bladder and set up cystitis, especially if there be any obstruction by a stricture to the flow of the urine; whereas in a healthy urethra it seems to be impossible for the organisms around the mouth of the urethra to ascend more than an inch or so up the urethra. The normal physical state of the mucous membrane and the constant flushing with urine seem to combine to keep bacteria out.

In males, therefore, the spontaneous direct ascent of organisms of the skin up the urethra to the bladder does not occur in health, but can only happen if there has been gonorrhœal urethritis or if the bacteria are carried in on an instrument, so that to prevent cystitis after instrumentation in the male the instrument and lubricant must be sterile, the anterior urethra must be well flushed with sterile or antiseptic lotion, and care must be taken to avoid bruising the walls of the bladder.

In females it was long held that spontaneous ascent of bacteria up the short urethra could occur, as "*spontaneous cystitis*" appeared to be far more common in women than in men. This view must now be held to be doubtful. Ascending infection can probably only occur in females as in males after a urethritis or after instrumentation, but descending renal infections are common.

Injury of the bladder-wall or urethra is far more likely to arise in women than in men during the manipulations of labour and of pelvic operations, or is produced by dislocations of the pelvic floor and the wearing of pessaries, such injury

being quite sufficient to determine a blood infection of the bladder-wall. Hæmatogenous pyelo-nephritis and bacilluria are also common in women, and are often mistaken for "cystitis."

Cystitis can also occur in females by direct tissue spread from the adjacent inflamed tubes and ovaries, though probably this is not common. Apart from this source, direct tissue spread of infection is very uncommon indeed, and can only occur when inflammation of the peritoneum, pre-vesical space, belly-wall, or adjacent viscera has spread by direct continuity to the walls of the bladder.

It is very doubtful whether bacteria can penetrate minute fissures in the rectal mucosa and attack the prostate and bladder.

Pathology.

Morbid Anatomy.

The inflammation is usually limited to a portion of the bladder-wall, but may involve the whole, the trigone, the regions around the ureteric orifices, and the posterior wall being the parts most often affected. Inflammation may affect the submucous and epithelial coats only, or may spread to the muscular coats, the pelvic cellular tissue and peritoneum.

In the early stages of an *acute inflammation* the wall appears intensely hyperæmic, shining, and œdematous, the œdema being shown by the presence of raised translucent vesicles ("œdema bullosum"). The blood-vessels of the submucous coat are engorged, and the tissue-spaces filled with plasma and round cells. Desquamation or necrosis of the epithelial cells takes place, and leucocytes and plasma make their way outwards between the layers of epithelium. The surface now looks red, rough, and granular, and is covered with shreds of pus and desquamated epithelial cells. At this stage resolution may occur, the products of inflammation being absorbed and the tissues restored by proliferation of epithelial cells and fibroblasts; or the process may become even more active. Leucocytes accumulate in the walls, and wide areas of tissue undergo necrosis and liquefaction, with the formation of ulcers on the surface, abscesses in the walls, or even gangrene of a large portion of the wall. Complete exfoliation of the mucous membrane and gross perforation of the walls are rare complications.

The inflammatory process may spread through the local tissue spaces and set up pericystitis in the form of localised

abscess or spreading cellulitis, and lead to infection of adjacent organs and tissues, and sometimes to peritonitis.

The process may spread by way of the lymphatics to the hypogastric and external iliac glands, giving rise to swelling or abscess, or it may enter the blood, giving rise to sapræmia, pyæmia, and septicæmia, but in most cases the effect on the blood is surprisingly small.

In chronic cases the change may be limited to the region of the trigone and ureter, or involve the whole bladder, and be superficial or interstitial.

With the cystoscope the wall may appear to be covered with a ramification of small blood-vessels, the contained blood being for the most part venous in colour, or local patches of diffuse redness may be seen. The epithelium lacks lustre, is dull and rough-looking, and may be altered in colour, being white or bluish-grey, or stained by silver nitrate and other chemical applications. The surface is covered here and there with adherent flakes of purulent or epithelial *débris*. Rough, red, velvety granular patches are not uncommon, and areas covered by inflammatory polypi and clear, pedunculated vesicles. These polypi are produced by localised epithelial and submucous infiltration with inflammatory cells and fluid, the vesicles being formed by the heads of the polypi swollen with serum. Lymphoid follicles may appear and present a characteristic picture, as do chronic ulcers, single or multiple, small or large, their floor covered by adherent membrane or phosphatic *débris* and secondary calculi. In the late and healing stages of a chronic cystitis leukoplakia may be seen, consisting of patches of white epithelial plaques rising from a field of thinned and flattened-out epithelium.

Interstitial inflammation produces a fibrosis of the bladder-wall and degeneration of the muscle-fibres, so that the wall of the bladder becomes greatly thickened and rendered less elastic and distensile, though some of the increase in thickness may be due to muscular hypertrophy caused by associated urethral obstruction or too frequently repeated micturition. The size of the bladder-cavity is diminished, and the bladder may not be able to hold more than three or four ounces of urine. In a few cases of healed tuberculosis the bladder is no larger than a thimble. The retro-peritoneal fatty tissue may become dense and sclerosed, so that the peritoneum becomes fixed to the bladder-wall, and can no longer slide up and down in front of it—a point to remember at operation. Chronic abscesses may be encountered in the walls of the

bladder and in the immediate neighbourhood. Finally, a condition must be mentioned where the bladder is set in a dense fibro-lipomatous mass of pelvic cellular tissue.

Symptoms and Signs.

The symptoms of cystitis are not characteristic, since they closely resemble those of pyelitis and posterior urethritis; so that the diagnosis cannot always be made for certain, and depends rather on the accurate estimation of physical signs than on the appraisement of symptoms.

Acute Cystitis.

Acute cystitis is not common, and is ushered in suddenly with pain, increased desire to micturate, and cloudy urine.

As soon as micturition begins an agonising pain is felt, which increases in severity as the act proceeds, especially at the expulsion of the last few drops of urine, but gradually wears off in a few minutes, leaving behind a dull aching pain in the hypogastrium or over the sacrum. The pain is felt in the neck of the bladder, along the under-surface of the penis, and in the glans itself. A frantic desire to micturate that cannot be resisted comes on every fifteen minutes or so, or even more often, so that a kind of false incontinence is produced, as severe by night as by day. The urine is cloudy with pus and phosphates, but the deposit sinks rapidly to the bottom of the glass. It may be odourless, or emit a most offensive smell.

A few drops of blood are sometimes squeezed out with the last few drops of urine, but profuse hæmaturia is rare.

The three glass tests cannot be applied in acute cystitis, as the bladder does not hold enough water. The urine may be acid, alkaline, or ammoniacal, and contains an amount of albumen proportional to the amount of pus, an amount which seldom rises above one sixth of the volume of urine. Under the microscope are seen pus-cells, epithelial cells, crystals, red blood-corpuscles and bacteria. A cast of the bladder mucous membrane, partial or complete, is sometimes passed, and causes great agony during its passage. Palpation of the abdomen above the pubes reveals a small, contracted and highly tender bladder, and rectal examination reveals a hot, swollen and tender bladder base, which should not be mistaken for prostatitis. Instrumental interference is unwarrantable, nor would the bladder tolerate it.

The general symptoms of sapræmia are usually in abeyance,

a fact which is less surprising if the function of the bladder as a reservoir be remembered.

If, however, the bacteria can produce irritating bodies as by the decomposition of urea (*proteus*, staphylococcus), the wall of the bladder is so damaged that toxins are absorbed and all the signs of a general toxæmia may appear, namely pyrexia, sweating, wasting, anorexia, nausea, constipation, restlessness, and general malaise.

Chronic Cystitis.

The symptoms are of similar nature to those in acute cystitis, but are less severe, and there are few signs of any effect on the general health except in tuberculous cases, though an interesting complication sometimes seen is the presence of inflamed joints, which closely resemble gonorrhœal joints.

The disease may come on as a result of acute cystitis, which does not resolve, or be insidious and mild from the first.

Pain is not severe, and is absent except during micturition.

Urination is performed every hour or so, but the call is not imperious. In very chronic cases this increased frequency is rather the result of the diminished capacity of the bladder than of irritation.

Pus appears in the urine in varying quantities, often mixed with strings of mucus and phosphatic *débris*. The determination of the source of the pus is discussed under "Diagnosis."

On examination a small, thickened, slightly tender bladder may be felt, especially by combined rectal and abdominal palpation, and attempts to fill the bladder with lotion for purposes of lavage or cystoscopy may show that the capacity is diminished to perhaps four or five ounces.

The cystoscope reveals a varied picture—sometimes a general increase in the finer blood-vessels with venous engorgement, at other times localised rectangular patches, hyperæmic, lack-lustre, swollen, and œdematous, and on occasion ulcers, distended mucous cysts, or lymphoid follicles.

Diagnosis.

Differential Diagnosis.

It is often a matter of some difficulty to distinguish cystitis from—(1) pyelitis, (2) posterior urethritis.

1. *From pyelitis.*

Descending hæmatogenous pyelo-nephritis, unilateral or bilateral, is now known to be a common affection, yet all the

symptoms point to the bladder—painful, irritable bladder, and pyuria. The case is often treated for cystitis, with no effect on the disease, owing to insufficient examination and because this fact is not yet realised (see Ch. VII, Sect. I).

In all cases of apparently spontaneous cystitis a renal origin should be suspected until it has been definitely excluded. If there is pain or tenderness in one or both loins, and, more important still, if the temperature is raised above 100° F., the symptoms are due to pyelitis. Cystitis with fever is extremely rare. An onset with profuse hæmaturia almost certainly means pyelitis.

The urine in pyelitis is acid, seldom alkaline, contains a larger amount of albumen than the pus can account for, one-sixth or more, and the pus sinks less slowly and is far more profuse than in cystitis.

Palpation may reveal a tender, swollen kidney, and the X ray may show a renal calculus. Finally, when the acute stage is over the cystoscope reveals pus descending from one or both ureters.

In women after parturition so-called cystitis is far more often a mild pyelitis.

Golden Rule.—Never be content with a diagnosis of spontaneous cystitis until pyelitis has been excluded.

2. *From posterior urethritis.*

No mistake is more often made than to take a gonorrhœal posterior urethritis for cystitis. The symptoms of posterior urethritis are the same as for cystitis, namely painful micturition, increased frequency of micturition, pyuria, and terminal hæmaturia. The disease appears three to five weeks after the beginning of the acute anterior urethritis, and the yellow meatal discharge may cease coincidently with it.

The diagnosis can be made by making the patient pass water into three glasses, and better still by doing so after the anterior urethra has been washed clean with antiseptic lotion by the method of Janet (*vide infra*).

In posterior urethritis the first glass contains pus and threads, the second is almost clear, the last is quite clear unless phosphates be present (soluble in acetic acid).

In cystitis the third glass is more cloudy than either of the other two, as pus tends to collect at the base of the bladder and be passed at the end of micturition.

Cystitis complicating gonorrhœa is extremely uncommon, and when it does occur it is usually due to secondary organisms rather than the gonococcus.

Complete diagnosis includes: (1) The bacteria present; (2) the predisposing causes present.

1. *The bacteria* are detected by microscopic, cultural, and inoculation experiments. A single pure strain may be obtained or a variety of different organisms, and in severe cases anaërobes are found if looked for by suitable methods (Jungano). The tubercle bacillus may lurk behind secondary contaminating organisms but can be separated without much difficulty by the most recent methods.

Bacteria that flourish in an acid urine are the tubercle bacillus, the colon bacillus, the gonococcus, and certain strains of staphylococci and streptococci.

All bacteria except the colon bacillus and the gonococcus appear to flourish in an alkaline medium, and certain bacteria actually turn the urine alkaline by decomposing urea, the *Proteus Hauseri* being the best known instance, but certain strains of staphylococci can also do so.

2. *The predisposing causes.*—For the sake of prognosis and treatment it is essential to discover the predisposing causes in any particular case by routine examination, the causes including instrumental damage, calculus, tumour, pregnancy, and parturition, pelvic prolapse, any causes of residual urine, urethritis, diseases of the nervous system, diabetes.

Treatment.

1. Prophylaxis.

The objects are first to prevent, remove, or modify predisposing causes, secondly to prevent the access of bacteria to the wall of the bladder.

(a) *Predisposing causes.*—The utmost gentleness should be used when passing an instrument into the bladder to avoid bruising the walls; a stone or tumour should be removed as soon as the diagnosis is made; the use of strong caustic applications should be avoided; pelvic prolapse and other diseases of the female pelvic viscera should receive attention.

Any cause of chronic back-pressure and residual urine, such as a urethral stricture or an enlargement of the prostate, should be removed or remedied. Glycosuria should be diminished by diet and drugs, excessive alkalinity of the urine altered, and diseases of the nervous system controlled.

(b) *The access of bacteria.*—Urethritis should be carefully treated and an effort made to reduce the urethral mucous membrane to its normal healthy resistant state.

The passage of an instrument is an evil, and should never be carried out except in the endeavour to remove a worse evil. If instrumentation must be performed no trouble can be too great to ensure that no bacteria shall be carried into the bladder by the instrument, more especially in cases of retention from nervous disease. Five things have to be sterilised: the hands of the surgeon, the glans penis, the instrument, the lubricant, and the urethra.

The glans penis swarms with germs such as the *Bacillus coli* and staphylococci. It is uncovered, cleansed with soap and water, especially around the meatus, and covered with a swab soaked in 1:100 lysol solution. The hands of the surgeon are washed with soap and water in a weak solution of lysol, soaked for two minutes in aqueous carbolic 1:80, and covered with boiled rubber gloves.

The best lubricant is paroleine or liquid vaseline, which can be efficiently sterilised in the following simple manner, the only paraphernalia required being a spirit lamp and a small Turkish coffee-pot or enamelled tin to hold four or five ounces of water. Half fill the pot with water and pour a layer of paroleine on to the top to the depth of an inch. Put the tin on the spirit lamp and allow the water to boil furiously for at least three minutes. The oil is broken up into small fragments and heated to the temperature of the water. Allow the pot to cool, having covered it over with a metal or muslin cover. The oil settles into a clear layer at the top, and is sterile and ready for use.

It is usually sufficient to dip the catheter into this, but if it is desired to lubricate the urethra more thoroughly we are in the habit of sucking up a drachm of the oil into a boiled stylo-filler and injecting it well home into the anterior urethra. The lubricant should not be smeared on the surface of the catheter with the finger.

The instruments may be sterilised in various ways. All metal and rubber catheters must be boiled for three minutes in plain water and put out on sterile towels or into a dish of saturated boracic solution. Most modern gum-elastic catheters can be boiled, such as the Albicaud and the Porgés, and if used in neuropathic cases should always be boiled just before use. Great care should be taken to watch for the appearance of any roughness of surface, when a new catheter must be obtained. After use gum-elastic catheters must be syringed out with hot soda solution to remove the fatty lubricant, and then rinsed through under the tap with a stream

of cold water. They can then be sterilised by the dry method or by the wet method (*vide* Ch. IV, Sect. V).

The dry method.—The inside of the catheter is dried by attaching an indiarubber bellows and pumping air through. The catheter is then dropped into a closed chamber containing formalin vapour for twenty-four hours. The "Paraform" steriliser is one of the most convenient forms on the market.

The wet method.—The catheter is dropped into a glass tube containing aqueous corrosive sublimate solution 1:500. Glass tubes of suitable size and a bottle of compressed tabloids of corrosive sublimate are provided by the instrument-makers.

The urethra may harbour bacteria for an inch or more from the meatus, but the deeper parts are sterile. *The urethra can be swept clear of germs for the purposes of examination by means of irrigation after the method of Janet.* Three pints of saturated aqueous solution of boracic acid or of oxycyanate of mercury 1:4000 are placed in an irrigator, four feet above the level of the penis. The urethra is then flushed by means of a urethral nozzle and shield, the compressor urethræ preventing the fluid from passing back beyond the bulb. With these precautions there is no fear of carrying bacteria into the bladder.

The access of bacteria from a suppurating lesion of the kidney should be controlled or prevented by appropriate treatment (see Ch. V, Sect. I).

A highly acid state of the urine is the most potent factor in preventing the growth of bacteria in the urine, whereas in alkaline urine the growth is luxuriant. Gouty old men with enlarged prostates and highly acid urine may go for years free from infection.

When there is risk of infection, prophylactic doses of urotropin (gr. iii) and acid sodium phosphate (gr. xx), which render the urine highly acid, should be administered three or four times a day.

2. Curative Treatment.

General treatment consists in the application of bodily rest, general supporting and tonic treatment, appropriate diet and drink, the exhibition of urinary antiseptic drugs, and attempts to raise the general blood-resistance by the use of vaccines and sera.

Local treatment consists in removing any exciting cause, ensuring complete emptying of the bladder by regular catheterisation or permanent drainage, and the application of

physical flushing and chemical antiseptics to the bladder itself.

The treatment of acute cystitis differs from that of chronic cystitis chiefly in that in the former lavage is never employed.

Acute Cystitis.

The patient is kept at rest in a warm bed. In the early stages a diet of citrated milk is adhered to (sod. citrate, gr. xx, ad 1 pint), but as the acuter signs subside a return may be made to a mixed diet, all rich and seasoned foods being scrupulously avoided, such as rich sauces, curries, smoked and salted meats and fish, spices, mustard, radish, salads. Tea, coffee, and, above all, alcohol, must be avoided. In addition to milk large quantities of water should be imbibed (six to twelve pints in the twenty-four hours), with the object of washing out the bladder from above. The water may be taken in the form of alkaline diuretic waters, such as Contréxeville, Vichy, Evian, Wildungen, etc., or in the form of weak vegetable infusions, such as the infusion of buchu or uva ursi. The object is to render the urine bland and non-irritating.

Nothing relieves the painful spasm so much as a hot bath, which can be repeated two or three times a day, and the patient being allowed to sit in it for half an hour at a time if the heart is in good order.

In the intervals hot bran-bags, hot-water bottles, or hot fomentations can be applied to the perinæum and abdomen, and relief may sometimes be obtained by the application of half a dozen leeches to the perinæum. Hot rectal infusion of salt solution, applied continuously at a temperature of 110° F., is sometimes beneficial. The bowels should be kept well moved by means of enemata.

Drugs may be applied locally or generally.

Suppositories of morphia (¼ gr.) and belladonna (1½ gr. alc. extr. B.P.) are useful, or the drugs may be applied dissolved in an ounce of warm water by means of a rectal syringe, using such doses as tr. opii ♏xxx, antipyrin gr. xx, chloralhydrate gr. xx, tr. bellad. ♏xx.

Subcutaneous injections of morphia may be required for a day or two in sufficient doses to control the pain.

For oral administration the following mixture is as good as any :

Pot. citratis . . .	gr. xx
Tr. hyoscyami . .	♏xx
Em. chloroform . .	♏x
Inf. buchu ad . .	℥ss

℥ss *quartis horis* ex. aq. Oss.

The balsams and acid sodium phosphate had better not be used in acute cystitis, as they increase the irritation.

As a general rule, in acute cystitis it is wise to leave the bladder alone until the acuter symptoms have subsided. On the treatment outlined above the symptoms abate in a very few days, when it is time enough to begin instillations or lavage as described below. We hesitate to employ strong instillation of cocaine, argyrol, protargol, or silver nitrate during the acute stages, as advocated by Guyon and the French school.

Chronic Cystitis.

The main outlines of treatment are much the same as for acute cystitis, save that they need not be pursued so vigorously, and the patient need not necessarily keep his bed. Fresh air, preferably sea-air, gentle exercise, and general tonic treatment are most important adjuvants to successful treatment.

The skin and the bowels must be kept active and clear.

Free diuresis must still be encouraged, but the drugs administered orally may be changed with advantage. The following represent types of prescriptions advised for an adult:

℞.	Hexamethylenetetramini (urotropini)	gr. v–vii
	Acidi sodii phosphatis . . .	gr. xxx
	Em. chloroform	♏x
	Aq.	ad ℥ss.
		F.m.

S. ℥ss *t.d.s.* ex. aq. Oss. p.c.

℞.	Acidi borici	gr. v
	Sodii benzoatis	gr. x
	Syr. tolutani	ʒj
	Aq. cinnamomi	ad ℥ss.
		F.m.

S. ℥ss *t.d.s.* ex. aq. Oss. p.c.

℞.	Olei santali (aut. olei terebinthinæ) .	♏x–xv
	Tr. quillaiæ	♏x
	Aq. menth. pip.	ad ℥ss.
		F.m.

S. ℥ss *t.d.s.* p.c.

If the oils are used it is important to watch their effect on the stomach and kidney. If they disagree they may lead to pain after food and nausea, or to pain in the back of the loin and albuminuria.

Lavage is a most important element in treatment, as it can be made to act beneficially in several ways; first, by mechanical flushing and cleansing of the surface of the mucous membrane; secondly, as an antiseptic or astringent agent; thirdly, as an agent to distend the bladder and gradually increase its capacity for holding fluid in those cases where the bladder is contracted.

These are the methods in common use for flushing out the bladder: (1) The method of Janet, the sphincters being overcome by hydraulic pressure; (2) the common method by the passage of a catheter through the sphincters.

In chronic cases, where there is no other call for a catheter, we prefer the method of Janet, as it saves the passage of a catheter and helps to increase the size of the bladder.

In cases where a catheter has to be passed to relieve residual urine, as in cases of paralysis or enlarged prostate, then it is more convenient to proceed with the second method.

1. *The method Janet.*—Apparatus required: A douche-tin to hold at least three pints of fluid, six feet of rubber tubing and a clip, a urethral nozzle and shield, a stylo-filler, a sterilised 2 per cent. solution of novocain nitrate, some swabs, a bottle of lysol, a receiver.

The nozzle and stylo-filler should have been sterilised in boiling water. The douche-tin is filled with a suitable solution and is suspended from a nail five feet above the level of the bladder. The patient lies on his back with a receiver beneath the perinæum and thighs. The glans penis is cleansed with lysolised swabs. The stylo-filler is made to take up a supply of novocain, is inserted within the meatus, squeezed, and withdrawn, the solution being held in the urethra by means of compression of the tip of the penis with the other hand. The anterior urethra is now full of novocain solution. With a finger of the right hand on either side of the bulbous urethra, the solution is stroked backwards into the deep urethra. After a few minutes the spastic reflex of the compressor urethræ will be found abolished. The urethral nozzle is now taken up by the fingers of the right hand, which simultaneously compress the rubber tubing just above the nozzle, and the clip is removed. The nozzle is

inserted into the urethra, and, after the anterior part of the urethra has been flushed with fluid, is made to block the meatus completely. The fluid now presses its way through the compressor urethræ and into the bladder, producing a thrill. As much fluid may be injected as the patient will stand without discomfort (ten to twenty ounces), the nozzle being then removed, and after a minute or so the patient asked to micturate into the receiver. The process may be repeated two or three times, and can be carried out once a day if necessary in chronic cases, but usually twice a week is sufficient. After a few trials the use of novocain can be dispensed with as the patient learns to relax the compressor voluntarily and with ease.

This method should only be performed by the surgeon himself, as it requires some skill and experience.

Lavage by means of a catheter.—A catheter is passed into the bladder in the ordinary way with full antiseptic ritual. The larger the catheter the better. A soft rubber catheter may be usefully employed if it can be passed with ease, but in many cases a gum-elastic catheter will have to be used. The best modern gum-elastic catheters can be boiled. A two-way catheter should never be used, as the chief object of the wash is to distend the folds of the mucous membrane so as to flush them thoroughly. The urine is drawn off completely, and fluid is then injected. The temperature of the fluid should be 105° F., and the amount injected each time should be four ounces.

A metal or glass syringe to hold four ounces, with a snugly fitting metal or glass piston, can be obtained from the best instrument makers. The syringe must take to pieces easily for cleaning, it must be capable of being boiled, the piston should work smoothly and evenly and should not leak, and care should be taken not to inject air.

For routine work in hospital wards it is more convenient to use a douch tin with rubber tubing and clip, and a glass nozzle which can be inserted into the end of the catheter. An indiarubber ball syringe is convenient for a patient's own use. The old method of using a syphon funnel is quite obsolete.

Lavage should be continued until the fluid comes away clear, and a few ounces of fluid may be left in the bladder with advantage if the fluid is unirritating.

Solutions for lavage.—Solutions may contain antiseptic agents, astringent agents, or agents having both actions.

The solution should be made up when possible with boiled, distilled water from which all foreign matter has been sedulously removed. Failing this, boiled tap-water poured through a fine muslin filter will suffice. The temperature of the solution should be 105° Fahr.

Agent.	Strength.	Action.
Boric acid . . .	Saturated solution = 15 grains to the ounce.	Astringent, inhibits bacterial growth.
Oxycyanate of mercury .	1 : 6000–1 : 4000	Non-irritating, strongly antiseptic.
Potassium permanganate	1 : 4000–1 : 1000	Antiseptic and astringent.
Silver nitrate . . .	1 : 10,000–1 : 5000	Astringent and antibacterial.
Corrosive sublimate .	1 : 50,000—1 : 30,000	Antiseptic, very irritating in greater strengths.
Zinc permanganate .	1 : 4000–1 : 1000	Astringent.
Zinc sulphate . . .	1 : 4000–1 : 1000	Astringent.

Instillation is a very valuable method of treatment. especially for cases complicated by posterior urethritis, and can be performed with the syringe of Guyon or of Ultzmann, or when these are lacking by means of an ordinary syringe and catheter. The syringe is filled with thirty minims of solution, the patient passes water, the urethral tube, lubricated with *glycerine*, is pushed down the urethra until the resistance of the compressor is felt at the depth of some six inches. The tube is then pushed onwards for another one or two inches through the compressor, so that the eye lies well within the deep urethra, the solution is injected and the tube withdrawn. In this way strong concentrated solutions can be applied to the deep urethra and bladder often with remarkable benefit. Pain after the injection is relieved by a hot bath, and it is better not to use cocaine, but if silver salts are being used the hydrochloride salts of cocaine, eucaine, novocaine, etc., will decompose the silver, so that special solution of the nitrates of these salts must be kept for this purpose.

If oil be used it prevents the antiseptic from getting at the wall of the bladder, whereas glycerine aids the process by prolonging the action of the drug.

The method of instillation can be applied with benefit immediately after an irrigation by the method of Janet.

Solutions used.	Strength.
Silver nitrate	Work up from gr. j to the ounce, to gr. xx, xxx or even xl to the ounce.
Protargol	5–10 per cent.
Potassium permanganate .	1 : 200.

Surgical measures.—In obstinate cases, or where it seems impossible to keep the bladder free from residual urine and back-pressure, continuous drainage may be instituted either by a catheter *á demeure* or by supra-pubic or perinæal incision. The supra-pubic route is the better, and the application of an Irving's dressing keeps the bed dry and enables lavage to be most easily performed. Continuous irrigation can be instituted if two tubes are inserted, by the use of simple mechanical devices, a method that appears to be of especial value as a preliminary measure to enucleation in old men with enlarged prostates and a severe cystitis.

If a stricture be present it is far safer to divide it at once by internal urethrotomy and either tie a catheter into the bladder or instil thirty drops of silver nitrate solution (gr. v to the ounce). The establishment of free drainage carries with it far less risk than attempts to dilate a stricture gradually when the cystitis is at all severe.

In a few obstinate cases that present chronic ulceration of the walls, benefit may be obtained by painting the ulcers with stimulating lotions such as strong silver nitrate through an endoscopic tube or after supra-pubic cystotomy.

Vaccine treatment is seldom required for a pure cystitis, though in obstinate cases it should be given a prolonged trial. The patient's own bacteria should be isolated and prepared as a vaccine.

SUMMARY OF PROCEDURE IN DEALING WITH A PATIENT SUFFERING FROM SYMPTOMS OF "CYSTITIS."

1. Never employ lavage or pass an instrument at the onset of such symptoms.

2. Put the patient to bed, take the temperature, and find out if the kidneys have been painful or are tender.

3. Examine the urine, and send it to a bacteriologist for an expert report.

4. In the meantime give urotropin.

Lavage should not be employed till the acute symptoms have abated, and then only if there has been no painful or tender kidney; if no tubercle bacilli have been found; if the pyuria does not disappear with the mitigation of symptoms.

If lavage cures the pyuria the diagnosis of cystitis as opposed to pyelitis is rendered complete.

CHAPTER IV.

TUBERCULOSIS OF THE BLADDER.

Ætiology.[1]

The disease is caused by infection of the walls of the bladder with the tubercle bacillus, which may reach that position by three different paths:

1. *Along the walls of the vas deferens* secondary to a tuberculous epididymitis.
2. *Along the walls of the ureter* secondary to a renal tuberculosis.
3. *Direct from the blood-stream* in the walls of the bladder (primary).

Primary tuberculosis of the bladder is seldom if ever seen in museum specimens, but there is cystoscopic evidence to show that the first deposit of tuberculosis in the genito-urinary tract may be from the blood direct into the submucous tissues of the posterior superior wall of the bladder (Fenwick).

In the usual course the tubercle bacilli are deposited primarily in the epididymis or the kidney and spread down in the wall of the vas deferens or the ureter until they reach the wall of the bladder just above and to the outer side of the mouth of the ureter. At this spot a submucous deposit of miliary tubercles is formed, which may break down and form a tuberculous ulcer. The bacilli are not carried to the bladder by the stream of urine and implanted on the walls, but work their way along in the submucous or peri-muscular coat of the ureter itself. Tuberculosis of the bladder is most frequently met with in adult males as the most prominent tuberculous lesion in the urinary tract.

Chronic gonorrhœa and excessive coitus are said to be predisposing causes, with how much truth is difficult to say.

The disease is uncommon in females except as a late complication of advanced tuberculosis of the kidneys and ureters.

[1] See Ch. VIII, Sect. I, "Tuberculosis of Kidney."

The widespread occurrence of this complaint can only be put down to the common habit of spitting, and to the careless methods of procuring cows' milk for food.

Pathology.

Morbid Anatomy and Histology.

The earliest deposit is seen either around the mouth of one ureter (renal infection); above and to the outer side of one ureter (testicular infection); or on the posterior superior wall (primary infection) as a raised, red, submucous patch covered by tiny shreds of adherent white *débris*. As time goes on this patch increases in size and grey pin-point areas become visible. Later still these grey points coalesce and give place to large yellowish areas of irregular size and shape, and eventually these in their turn break down and engender definite ulcers. Neighbouring ulcers coalesce and form large irregular areas denuded of epithelium, the floors being irregular and covered with crusts and sloughs or with projecting exuberant masses of granulation tissue (polypi) which flutter about in the urine, the edges being rounded or irregular and undermined, and surrounded by swollen, reddened mucous membrane, which may exhibit grey or yellow tubercles.

These changes are represented histologically as follows:

Tubercle bacilli are deposited in the submucous tissue spaces, and produce hyperæmia, exudation, and proliferation of round cells and spindle-cells, with the formation of miliary tubercles which coalesce, undergo necrosis, and give rise to submucous collections of yellow, cheesy material. The epithelium on top of this area undergoes necrosis and disappears, leaving the cheesy material to be discharged into the bladder so that an ulcer is formed, the floor and edges of which are lined by tuberculous granulation tissue.

The process may spread through the muscle coat to the peri-muscular connective tissues, producing caseation and abscesses in these tissues, and so to the neighbouring viscera, peritoneum and skin. Fistulæ and secondary infection may thus arise, but in chronic cases there is usually a progressive sclerosis of the fibro-lipomatous perivesical tissue continuous with that surrounding the ureter and kidney.

The walls of the bladder itself are thickened by reason of muscular hypertrophy from constant micturition and from a progressive sclerosis, so that the cavity of the bladder is

diminished in size, and in females in chronic cases it may hold no more than an ounce of urine ("thimble bladder"). Secondary infection occurs sooner or later, the bacteria making their way from the bladder to the kidney or by way of the urethra, or else as the result of a fistulous opening on to the skin or into the bowel.

Bacteriology.

The bacillus of Koch can be found without much difficulty unless its presence is masked by the presence of numerous contaminating organisms.

The specimen of urine must be obtained free from the smegma bacillus (see Ch. VIII, Sect. I). The new method of isolating the tubercle bacillus with "Antiformin" will no doubt prove useful.

If secondary bacteria are present their character should be determined. The most common varieties are bacilli of the colon group, staphylococci, streptococci, and the *Proteus Hauseri*.

Symptoms.

The disease is ushered in suddenly by two chief symptoms—*burning pain during micturition* and *increased frequency of micturition*, the subject being a young male adult. *The pain* is not very severe, and may be scarcely more than a burning feeling; it is felt along the deep urethra and in the glans penis. The *frequency of micturition* is increased, water being passed every hour or every half hour, and *at night* as well as by day. A greatly increased quantity of urine is passed, caused by reflex irritation of the kidney, the urine being pale but clear. *Hæmaturia* is not common at the onset, or at any time in the course of the disease; but sometimes a few drops are passed at the end of micturition for a few days after the onset, and now and then the approach of the disease may be heralded by a profuse hæmaturia lasting two or three days, and unrelieved by rest. Hæmaturia is seldom repeated except in the late stages, when there is extensive ulceration.

In the early stage the urine may appear clear to the naked eye, though examination will reveal a trace of albumen and even tubercle bacilli; but sometimes little white, flaky shreds are seen floating in a clear urine, which are very suggestive if there has been no previous urethritis. The pain may increase in intensity, and spread to the back of the

sacrum and into the thighs, and with this will go increased frequency of micturition; but usually all symptoms disappear after a few weeks' treatment, and for a time the disease might be thought to have disappeared, though all the time it is progressing slowly in the wall of the bladder. From time to time the symptoms burst forth afresh.

In cases of primary tuberculosis of the posterior superior wall, the chief symptoms are those of an irritable bladder, accompanied by pains in the glans penis; hæmaturia seldom occurs, and a period of latency quickly ensues.

In cases secondary to the epididymis the onset is with sudden profuse hæmaturia, followed by a burning in the urethra and increased frequency of micturition. The nodule in the epididymis is a great help in diagnosis.

In cases secondary to the kidney increased frequency of micturition day and night is the most marked symptom accompanied by polyuria, and with this may go pain in the urethra or pain in one loin, and pyuria is usually well established.

In the early stages there are no general symptoms—no pyrexia, no wasting, no anæmia—and the patient appears healthy and well. It is not till the onset of secondary infection, or of very extensive ulceration or of disease of the whole urinary tract, that cachexia and hectic temperature are the rule, and in these later stages the disease ceases to run an intermittent course, the suffering being constant from the agonising calls of the bladder to empty itself.

Signs.

The urine is always pale and increased in quantity. It may be clear or may contain merely a trace of albumen, white flaky shreds, and tubercle bacilli, but very shortly it comes to contain definite pus, at first little more than a haze, later a white deposit. The discharge of pus for a long time may be intermittent, the periods of increased discharge being marked by the formation of fresh ulcers.

Red blood-corpuscles are often found in the centrifugalised deposit, even after the night's rest.

The finding of the tubercle bacillus in the urine is not an absolute indication of local disease, unless accompanied by pyuria or other local symptoms and signs (see Ch. VIII, Sect. I).

Routine examination of the genito-urinary tract is imperative, and in a large number of cases will reveal hard irregular tuberculous nodules in one epididymis, in one vesicula

seminalis, in the ureter (as felt by the rectum), or in the prostate. One or both kidneys may be enlarged and tender, and signs of tuberculosis of the lungs or alimentary canal will throw further light on the subject, but are by no means always present.

In this way a shrewd idea can be gained as to the nature of the disease and as to the primary focus, but in some cases there is nothing to guide the surgeon aright, and cystoscopy is needed to clear up the diagnosis.

It used to be held that cystoscopy was seldom required *in the male* in cases of tuberculosis of the bladder. The risks of setting up secondary infection were considered to be so great that at any cost cystoscopy was avoided. Owing to a change in modern conceptions of the origin of tuberculosis of the bladder it is now held that the patient's best chance of cure depends on *early* cystoscopy. Primary tuberculosis of the bladder is an uncommon event, the disease being secondary to disease in the kidney or epididymis or both.

If the kidney or testicle and vas can be removed in the early stages the bladder appears to be able to overcome its dose of tuberculosis, so long as no fresh doses are added from elsewhere. Without cystoscopy it is impossible to tell for certain whether one or both kidneys are infected, and what is the functional power of each.

Of course if both kidneys are palpable and tender, one or both testicles are involved, and nodules can be felt in the vesiculæ and prostate, it is not only dangerous but unwise to practise cystoscopy as there is nothing to be gained by it in diagnosis or treatment, and there is the risk of setting up secondary infection.

In cases suspected of early tuberculosis a fortnight's course of sandal oil (♏v *t.d.s.*) and urotropin (gr. v *t.d.s.*) should be enjoined, after which the patient should be cystoscoped with extreme antiseptic ritual in his own urine, or after careful lavage with oxycyanate of mercury 1 : 4000.

After inspection of the bladder-wall ureteric catheters should be passed up both ureters with the precautions mentioned on p. 185, and the urine so obtained should be submitted to complete investigation, both for pus-cells and tubercle bacilli and for the functional value of each kidney.

If one kidney and ureter be diseased they must be removed. If the kidneys be healthy and one testicle be diseased it must be removed. If both kidneys and testicles are healthy the

disease is primary and is best treated by tuberculin and sandal wood oil.

Ureteric catheterisation need not be carried out if one testicle is diseased, if no thickening of either ureter can be felt, if the kidneys are not enlarged or tender, and if the mouths of the ureters are seen to be healthy and clean urine is seen issuing from them.

The cystoscopic appearances of the bladder have been described under "Morbid Anatomy" (see p. 287), and consist of localised patches of redness, in the earliest stages, around the mouths of the ureters or on the posterior superior wall. Later the patches grow larger and show grey miliary tubercles or large, yellow, crude deposits. Later still definite ragged ulcers form, surrounded by infected mucous membrane, and may attain large dimensions, at which stage the bladder becomes intolerant of sufficient distension for cystoscopy.

Evidences of diseased kidneys and ureters may also be obtained by ureteric meatoscopy. The slit-like orifices of the ureter become dragged out into the shape of the inguinal ring, and eventually may become wide-mouthed and patent —the "golf-hole" ureter (see also p. 187). Clouds of pus or sticky coils of curd may be seen issuing from the ureteric orifices.

Diagnosis.

When a young man who has never had venereal disease presents symptoms of "spontaneous cystitis," *tuberculosis* is the condition that first rises to the mind, but *stone*, and to a less extent *simple ulcer*, have to be excluded, though, if the patient has recently been in South Africa or Egypt, *Bilharzia hæmatobia* is the most likely diagnosis.

If a young man *without venereal taint*, who usually sleeps well, is constantly awaked at night by calls to micturate, the diagnosis is tuberculosis of the bladder.

If there is a *venereal history* the two likely diagnoses are—cystitis secondary to a stricture or to locomotor ataxia.

In stone there is usually a previous history of renal colic and hæmaturia; the pain, increased frequency and hæmaturia occur chiefly in the day-time, and are relieved by rest, and the X-rays or the cystoscope at once reveal the true cause.

A simple ulcer can only be distinguished by the fact that tubercle bacilli are never found in the urine after repeated examinations.

The symptoms of cystitis, especially in women, are often

due to mischief in the kidney rather than in the bladder, such as tuberculosis or chronic pyelitis. General symptoms are more pronounced, the kidney may be enlarged and tender, and the cystoscope reveals a *general diffuse redness* of the whole bladder or around one ureter, with pus issuing from that ureter (see pp. 181, 276, 285).

The diagnosis is completed by finding tuberculous foci elsewhere by the cystoscope, and by the discovery of tubercle bacilli in the urine in conjunction with local signs of disease.

Tests of the blood-resistance to the tubercle bacillus and its toxins, such as the tuberculin test, the various opsonic tests, the Calmette ophthalmic reaction, the tuberculin cutaneous reaction, are alike of small value, as they are often fallacious, and when positive do not show anything more than that there is a focus of tuberculosis somewhere in the body. We have found the results disappointing, as we have proved the presence of tuberculosis even when the tests have been *negative*.

Course and Prognosis.

If the primary focus can be removed the disease in the bladder may become quiescent, and may seem to be cured, and tuberculin has an undoubtedly beneficial effect on vesical tuberculosis uncomplicated by tuberculosis elsewhere. At the same time it is unwise to speak of cure. All symptoms and signs may seem to disappear for three or four years or even more, only to break out afresh at the end of that time, and some favourable cases may linger on in this way for ten or fifteen years, the patients leading comparatively comfortable and useful lives.

In a few women the bladder contracts down to the size of a thimble and nothing is left but the trigone, the body being represented by a shell of dense fibro-lipomatous tissue. Absolute incontinence prevails, but the urine may contain little pus though plenty of tubercle bacilli, and there may be little or no pain.

The course in other cases is not nearly so favourable, especially in women who present themselves too late for nephrectomy. Ulceration proceeds apace, and secondary infection appears. There is a swinging temperature, rapid wasting, profuse sweatings, the colour of the lips fades away and the cheeks assume a waxy or earthy complexion. Micturition is so frequent as to amount to incontinence, and is

accompanied by intense pain. The end comes after eighteen months to two years in a variety of ways. Some patients die of uræmia, others of amyloid disease or of a septicæmia induced by secondary infection and the onset of fistulæ; others are carried off by tuberculosis elsewhere.

Treatment.

The general treatment consists in attention to the general health, which is strengthened and maintained by means of fresh air, good food, adequate rest, and graduated exercise leading up to full work. Tonics, cod liver oil, malt, and drugs such as creosote and guaiacol are beneficial, but the use of alcohol in any form irritates the bladder and should be interdicted.

Line of Treatment.

The first step is to complete the diagnosis as to the presence or absence of a primary focus apart from the bladder.

If a primary focus is discovered either in one kidney and ureter or in one epididymis and vesicle, it must be removed by surgical interference. If there is a deposit both in one kidney and in one epididymis, yet the ureter and vas are felt to be free, both foci are primary and should be removed, but the combination is very rare.

After the removal of such a focus, or in primary cases without any interference, the case is watched for six months or a year to observe the effect of the following treatment:

(1) *A course of sandal wood oil* (mv three times a day after food in capsules or suspended in mucilage).—The sandal wood oil should be omitted when the symptoms subside and held in reserve for a fresh outbreak.

(2) *A course of tuberculin injections.*—Tuberculin has been used for many years for vesical tuberculosis, and appears to produce more favourable results than is the case with tuberculosis in any other part of the body. Large doses can be used as they are well tolerated, and regular determinations of the tuberculo-opsonic index are not an absolute necessity.

The ideal way is to work in conjunction with laboratory reports of the blood index, so as to determine the optimum dose and the right spacing between each for the individual case. But for routine work as in the large out-patient departments of hospitals, it is found by experience that excellent results are obtained by proceeding as follows:

An initial subcutaneous injection is given of 1 : 4000 of a

milligramme of tuberculin (new "T.R.," old style of dosage; new style = 1 : 20,000), the injections being repeated every fourteen days, and if the symptoms subside the dose is gradually increased from 1 : 2000 up to as much as 1 : 400. It is seldom advisable to go beyond this dose, and as a matter of experience many cases seem to do excellently if kept on regular small doses such as 1 : 2000 or 1 : 1500 for months together.

A return of the pain and frequency is a sign either of too large or too small a dose. If the doses used are small at the time they should be increased and the effect noted. If they are large at the time, or if increase of the dose makes the symptoms worse, it is wiser to go back to some much smaller dose and gradually work up again or remain at a low dose altogether.

Despite the fallacious signs of improvement that occur from time to time in the natural course of a vesical tuberculosis, and the difficulties of judging the true course of the disease apart from regular cystoscopy, we are of the opinion that in tuberculin, wisely administered, we possess a remedy that can undoubtedly exert a beneficial effect on the course of the disease, and which undoubtedly prolongs life even if it does not cure. If both kidneys are extensively affected it is not wise to use tuberculin.

The opinion of the majority of the urologists is against local treatment of any kind for tuberculosis of the bladder, founded upon many years' trial of every kind and form of lavage, installation, and curetting operation. Such procedures have not appeared to cure the disease, and have usually made it worse by setting up secondary infection or fistulæ.

It is only fair to state that there has been a revival of local treatment in the last few years in Germany and France, and a number of cases of apparent complete cure have been reported in the literature.[1]

Two lines of treatment appear to have found most favour:

1. *Rovsing's Carbolic Acid Method.*

Fifty c.c. of warm (35° C.), freshly prepared carbolic acid aqueous solution (5 per cent.) are injected into the bladder after it has been cleared of pus by previous irrigation. This is held for three or four minutes, and the injection is then

[1] Holländer, 'Berl. klin. Woch.,' June 4th, 1906. Rosenstein, *ibid.*, February 3rd, 1908.

repeated until the fluid comes back clear. The bladder is left empty at the end of the sitting, which occupies some fifteen minutes. The process causes great pain, which is met by the use of morphia suppositories for some days, and is repeated once a week till the pus and tubercle bacilli disappear from the urine. Rovsing reported thirteen healings out of eighteen cases so treated, and others have reported similar successes.

2. *The Calomel Iodine Method of Holländer.*

An injection of sterilised 2 per cent. calomel oil emulsion is introduced into the bladder, as much being used as the bladder will conveniently take. A few minutes later a drachm of 5 per cent. potassium iodide solution is given by the mouth, which being excreted by the kidneys enters into combination with the calomel in the bladder. This effect is announced by intense pain, which must be controlled by a morphia suppository. The patient holds the solution in the bladder as long as possible. The treatment is repeated once a week for some five or six times, and is said to give most encouraging results.

One thing is essential to success in carrying out lavage on a tuberculous bladder—the access of secondary bacteria must be rigorously prevented.

CHAPTER V.

ULCERS OF THE BLADDER.

Ætiology.

ULCERS of the bladder are SIMPLE, SPECIFIC, or MALIGNANT. The two latter classes are considered in separate chapters.

1. SIMPLE.
   - A. *Consecutive:* Mechanical pressure of tubes, stones, instruments, pessaries.
   - B. *Spontaneous:* Bacterial infection of walls.
     - Acute perforating.
     - Chronic solitary.
   - C. *Symptomatic:* Diabetes.
     - Disease of the nervous system.
2. SPECIFIC.
   Tuberculous.
3. MALIGNANT.
   Epitheliomatous.

Simple Ulcers.

PATHOGENESIS.

The origin of the consecutive and symptomatic ulcers is evident, but that of the spontaneous is not so clear. Presumably these ulcers are produced by the action of bacteria, but it is a matter of speculation how the bacteria reach the wall of the bladder, whether by an embolic process, or by infection of lymphoid follicles. In acute cases gangrene of the bladder-wall occurs and leads to perforation, pelvic cellulitis and peritonitis. In chronic cases perforation is uncommon, but the wall of the bladder in the immediate neighbourhood becomes sclerosed and contracted, and eventually bladder epithelium may grow over the surface, producing a soundly healed scar. Before the healing stage is reached the floor of the ulcer is covered with phosphatic crusts.

Acute spontaneous ulceration is only met with clinically as a part of a severe cystitis. Signs of acute pelvic cellulitis

or peritonitis show when perforation has occurred, and in spite of attempts to drain the inflamed parts death is the common result.

Chronic spontaneous ulceration is uncommon. It takes the form of a solitary ulcer on the posterior wall of the bladder to the inner side of the ureters. At first it is little larger than a shilling, and appears as a cleanly cut ulcer surrounded by healthy mucous membrane; later on it spreads and becomes coated with phosphatic plaques, and finally it scars up, leaving a small bladder with dense, inelastic walls.

It occurs in young males with no venereal history. The onset is sudden, the symptoms being increased frequency of micturition by night as well as by day. Hæmaturia follows in a few hours and is often profuse, accompanied by a constant aching pain in the head of the penis or in the scrotal angle. The urine shows a few pus cells, but no specific bacteria in the early stages. Sooner or later the symptoms and signs of chronic cystitis become well established and last for a variable time. In the healing stage the only symptom that persists is increased frequency of micturition, caused by the decrease in the size of the bladder.

Diagnosis.

The diagnosis is made by cystoscopic examination after exclusion of—(1) tuberculous disease by the inability to find tuberculous nodules elsewhere or tubercle bacilli in the urine; (2) mechanical causes by the history; (3) diabetes and disease of the nervous system by routine examination. The position and character of the ulcer, the age and sex of the patient, and the sudden onset with profuse hæmaturia are the characteristic features.

Treatment.

Ulcers consecutive to stone, instrumentation, etc., should be given a chance to heal, the ordinary treatment for chronic cystitis being employed (see Ch. III, Sect. III). The most important measures are to keep the whole body at rest with the pelvis elevated; to support the general healing powers by means of good food, tonics, and fresh air; and finally to keep the urine as clean and non-irritating as possible. Lavage with lactic acid (3 per cent.) or acetic acid (1 per cent.) may be employed to get rid of phosphatic crusts.

In cases of chronic spontaneous ulceration the same course should be adopted, and in addition rest is obtained for the

worried bladder, the frequency and pain being controlled by sandal-wood oil and small doses of opium.

Operative Treatment.

If the ulcers show no signs of healing under this *régime* as evidenced by cystoscopy at regular intervals, it becomes necessary to apply more radical measures.

The ulcers should be gently curetted and painted with silver nitrate (gr. xx ad 1 oz) through the endoscope or operating cystoscope, or failing this, perinæal or supra-pubic cystotomy is performed, the ulcers thoroughly curetted, and the bladder rested by drainage for some weeks. The disease will usually yield to energetic treatment. If perforation should occur adequate drainage of the pelvic cellular tissue or peritoneum must be instituted.

CHAPTER VI.

TUMOURS OF THE BLADDER.

Ætiology.

THE true causes are unknown, though chronic irritation seems to play a minor *rôle* in aniline dye workers, amongst whom the disease is common (Leichtenstein), and oxaluria is sometimes held to predispose to papilloma.

Age.—Bladder tumours are uncommon before the age of thirty; between the ages of thirty and forty they are more often benign; after forty they are usually malignant. In children they are rare, but when they do occur they are usually sarcomata or myxomata, are of rapid growth, early fatal and quite inoperable.

Sex.—Men appear to be more often attacked than women in the proportion of 3 or 4 to 1.

Frequency.—Published figures show that bladder tumours form 4 to 8 per cent. of all tumours.

Pathology.

MORBID ANATOMY.

Classification.

A. EPITHELIAL TUMOURS:
- *Benign:* Papilloma.
  Adenoma.
- *Malignant:* Pedicled papilloma.
  Sessile polyp.
  Epithelioma.

B. CONNECTIVE-TISSUE TUMOURS:
- *Benign:* Fibroma.
  Myoma.
  Angeioma.
  Chondroma.
- *Malignant:* Sarcoma.
  Myxoma.

Papilloma and *epithelioma* are the only common tumours; the others are so rare as not to be worth considering in detail. For instance Albarran in a series of cases found 100 carcinomata, 21 papillomata, 2 fibromata, 3 myxomata, 2 sarcomata, 3 myomata, 1 angeioma.

Sarcomata are round-cell, spindle-cell, giant-cell or mixed. They, like myxomata, occur in children as smooth pedunculated or sessile tumours which grow rapidly, fungate early, and are quite inoperable.

Myomata and fibromata resemble those found elsewhere, originate in the walls of the bladder, and may grow outwards or inwards. They are of slow growth, and if removed tend only to recur locally.

Epithelial Tumours.

These are benign or malignant, pedunculated, sessile, or infiltrating.

The papilloma is a pedunculated tumour projecting from the surface of the mucous membrane, and may present numerous delicate filamentous processes like an open sea anemone, or may be smooth and lobulated. The filamentous or villous variety may be benign or malignant, the smooth variety is always malignant. The growths are often multiple (30–40 per cent., Albarran), and may occur in any part of the bladder, but in the large majority of cases (80 per cent., Fenwick) they are found on the postero-lateral wall of the bladder above and to the outer side of the orifice of one ureter. The pedicle can be lengthened by traction, which pulls the loose mucous membrane of the bladder into the pedicle from off the surrounding muscular coat. A large papilloma tends to drag upon the mouth of the neighbouring ureter, and may partially obstruct it, giving rise to hydronephrosis and secondary infection of the corresponding kindey. Less commonly a long papilloma "corks" the urethra as the bladder empties itself, interrupting the stream or setting up retention.

The sessile tumour is an uncommon variety; it projects into the bladder, but has a short, stout pedicle as thick as a finger or even thicker, which consists of tumour-tissue. The surface may be villous or smooth. This variety is *always malignant.* Sections of the sessile base or pedicle show that it consists of firm bands of connective tissue surrounding islands of epithelial cells, which may be seen invading the submucous and muscular coat.

The infiltrating tumour is attached to the bladder by a *wide* base, and presents two varieties:

(1) *A soft fungating mass of tumour-tissue* is seen projecting into the bladder, which can be curetted away without causing much bleeding, a large raw ulcer being left, the floor of which is formed by tumour-tissue invading the walls of the bladder over a wide area. This type is very malignant, and consists of epithelial cells lying in a delicate connective-tissue stroma, which project into the cavity of the bladder, and also invade the connective-tissue spaces and lymphatics of its wall.

(2) *An epitheliomatous ulcer* which lies upon the wall of the bladder. The ulcer is small, shows a rolled, raised edge, surrounding a friable floor covered with phosphatic *débris*. The base is *dense and hard*. In 70 per cent. of the cases the ulcer involves the lower third of the bladder and early involves the bladder base.

Histology.

A papilloma consists of a fine central core of delicate connective tissue containing large blood spaces, on the outer surface of which are arranged many layers of epithelial cells. A malignant papilloma, a sessile tumour, and an epithelioma show characteristic changes in their bases. The connective tissue of the submucous coat is increased in amount, and the tissue and lymphatic spaces are packed with epithelial cells isolated or lying in groups, of all shapes and sizes, many showing degeneration of their cytoplasm. Epithelial cells may be traced between the muscle-bundles and beneath the peritoneum in the pelvic cellular tissue. They can also be followed in the lymphatics to the regional lymph-nodes.

Mode of Spread.

These are four in number: by contact; by continuity; by lymphatics; by blood-vessels.

(1) *By contact* ("Kiss-cancer"). There is abundant evidence to prove that fresh tumours may arise at spots on the healthy bladder-walls constantly being touched by the surface of a growth. In this way multiple tumours may appear on the anterior wall of the bladder, the primary source being a large tumour on the posterior wall.

(2) *By continuity*. The epithelial cells grow down along the connective-tissue spaces of the submucosa, pierce the muscular coat and spread along in the pelvic and subperi-

toneal cellular tissues, and may thus reach the different structures in the neighbourhood such as the belly-wall, prostate, vesiculæ, and rectum. Albarran states that it is rare for the growth to spread along the walls of the ureter. Late in the disease the growth bursts into the rectum, into the peritoneum, or onto the skin. Infection of a palliative cystotomy wound is frequently seen.

(3) *By the lymphatics.* It has been maintained by some authorities that there are no lymphatics in the submucous coat of the bladder; but Albarran and others have brought convincing evidence to show that a rich submucous plexus of lymphatics does exist, the collecting trunks from which pierce the muscular coat, and as they do so are joined by the lymphatics of the muscular plexus. The trunks thus formed enter a plexus which lies on the outside of the muscular coat in the retroperitoneal tissues. The collecting trunks from this plexus enter the following groups of lymph-glands :

(i) Those from the anterior surface run up and out in the lateral ligaments of the bladder to enter (*a*) a lymph-node between the external iliac vein and the obturator nerve just behind the crural ring ; (*b*) to the middle gland of the middle chain of the external iliac group of glands. "Interrupting" glandular nodules may be found in the course of these lymphatics.

(ii) Those from the posterior surface: (*a*) The superior set run up and out to the middle gland of the middle external iliac chain. (*b*) Other trunks pass up and out along the obliterated hypogastric artery to end in a gland lying just in front of the bifurcation of the common iliac artery. (*c*) Trunks from the middle portion run back and out to end in the hypogastric group of glands. (*d*) Trunks arising from around the neck of the bladder run directly back around the sides of the rectum, ascend on to the anterior surface of the sacrum, and terminate in glands situated just beneath the bifurcation of the abdominal aorta.

The cancerous cells may enter these lymphatic trunks and pass to the corresponding lymph-glands. Authorities differ widely in discussing the comparative frequency of infection of these glands. Some considered that they are affected but rarely and only late in the course of the disease; others state that they are affected early. Material to settle this point is hard to obtain. The more pedunculated the tumour the less likelihood is there of lymphatic infection.

(4) *By the blood-vessels.* General metastases are met with

late in the course of the disease, especially in the lungs and liver, and seldom come within the ken of the surgeon.

Secondary Changes.

A deposit of phosphates is often seen on the surface of the papilloma or ulcer. Necrosis and ulceration are the rule as the disease runs its course.

Infection occurs sooner or later, usually from ascending infection following unwise instrumental interference, or sometimes from descending infection, especially if one ureter is being obstructed by the growth, and if the patent is rendered constipated by the unwise exhibition of iron to stay hæmorrhage. Infection leads to cystitis, peri-cystitis, and rarely peritonitis, or else to pyelitis and pyelonephritis.

If the growth presses upon one ureter the corresponding kidney becomes distended and later infected. If the growth "corks" the urethra the same thing happens to both kidneys.

Clinical States.

In the life-history of all bladder tumours there are three stages: the stage of *latency*, the stage of *painless hæmaturia*, and finally the stage of *painful spasm and irritability of the bladder*. In a certain number of cases, however, when an infiltrating epithelioma is present *as can be felt by rectal examination*, the second and third stages fuse and the onset is one of hæmaturia combined with painful bladder-spasm. *A history of sudden painless hæmaturia at the end of micturition in a man aged thirty to forty-five, should at once excite a suspicion of villous tumour of the bladder.*

The latent period is marked by no symptoms or signs.

The second period is ushered in by the occurrence of hæmaturia unaccompanied by pain in 84 per cent. of the cases of benign tumours. The bleeding is spontaneous, slight or profuse, and comes on in attacks at intervals which vary from months to years. The intensity of the bleeding tends to increase with each attack. The bleeding may occur only at the end of micturition, in which case it is certain it does not come from the kidney, or may be so profuse as to colour the water evenly throughout. The colour is usually a bright arterial red. The bleeding is increased by movements, and by instrumentation, and may be so severe and continuous as to bleed the patient to death. Indeed the most severe grades of secondary anæmia ever met with are those due to papilloma of the bladder.

At this stage there is no increased frequency of micturition, but the stream may be interrupted from time to time by impaction of the floating growth in the mouth of the urethra.

An aching pain in the kidney caused by dragging of the growth on the corresponding ureter is not infrequently complained of, and may mislead the surgeon into suspecting a renal origin for the hæmaturia.

The third stage is ushered in by agonising pain in the head of the penis or deep in the perinæum throughout or towards the end of micturition, and accompanying this pain is a greatly increased desire to micturate.

This pain may be due to infiltration of the walls of the bladder by the cells of the growth, causing frequent spasms of the bladder-muscles, in which case it is almost uncontrollable; or it may be due to the onset of infection and cystitis.

Later still, as the growth invades the pelvic cellular tissues and the enclosed nerve-tissues, intense aching and lancinating pains are felt along the course of the sacral nerves in the back of the sacrum, in the buttocks, and down the backs and inner sides of the thighs, along the course of the sciatic and obturator nerves.

The urine is clear and acid in the intervals between the attacks of hæmaturia, but at times particles of growth become detached and can be found in the urine. Their appearance when floated out in water or under the microscope is pathognomonic of neoplasm, but can tell *nothing* as to the benign or malignant nature of the growth.

Pus cells and phosphatic *débris* appear in the infective stages, and the urine may become alkaline and offensive and swarm with bacteria.

Palpation of the bladder can be carried out by the rectum and vagina and bimanually.

In the fungating non-infiltrating types of growth, though no hardness of the bladder base can be detected, yet bimanually the soft mass of the growth can be felt between the fingers, especially under anæsthesia.

When a hard infiltrating epithelioma is present it is at once detected as a dense, hard mass set in the bladder-wall above the prostate.

The smaller pedunculated growths cannot be felt at all.

The sound should never be used for *painless hæmaturia.*

Painless hæmaturia demands early cystoscopy, and should never be met by drugs and delay.

Cystoscopy, if it can be carried out safely and successfully, gives the most certain means of diagnosis.

Certain precautions and difficulties should be noted.

If the diagnosis is clear from the history of pain and hæmaturia and rectal examination, which reveals a hard plaque in the bladder base, then cystoscopy is not only not needed to confirm the diagnosis, but it is positively harmful to the patient as it may set up secondary infection and lead rapidly to death. Hence the rule that a rectal examination should always precede a cystoscopy for hæmaturia.

If the tumour bleed easily it may be impossible to get the bladder clear to enable a view of its interior to be obtained. In most cases after a few days of rest and Contréxeville water the bleeding ceases and the patient can be cystoscoped in his own urine. A prophylactic course of urotropin should also be administered. If the bladder has to be washed out a soft catheter only should be used and it is safer and wiser to proceed to operation at once; but if this is refused a silver wash should be given (two grains to the pint). For some reason or other lavage in patients with bladder tumour is very likely to lead to pyelitis.

A twelve-ounce distension of the bladder should always be obtained when possible, as in a smaller bladder the lax wall may present a very deceptive appearance of tumour.

Sometimes it is impossible to wash out the bladder, as the growth becomes impacted in the eye of the catheter. This difficulty may be got over by turning the patient on to his side.

A very large growth may fill the bladder and prevent any view being obtained by the cystoscope. If the bladder cannot be washed clear of the blood it is certain that the source is vesical and not renal, in which case particles of growth will usually be obtained to complete the diagnosis.

In the later stages the patient may become almost bloodless from repeated hæmorrhages and die of exhaustion. More often cystitis and pyelitis supervene and rapidly put an end to the suffering, which in some cases consists of excruciating bladder-spasms every five or ten minutes which nothing can control.

Fistulous openings onto the skin or into the bowel may appear. Uræmia is sometimes induced by intermittent urethral obstruction and distension of the kidneys. Except in the infiltrating types cachexia and wasting are not common until late in the course of the disease, when they make their appearance accompanied either by an intense pallor or a

deep bronzing of the skin. Extensive metastatic deposits by way of the blood-vessels may appear, but they do so late, and the patient is usually carried off by local infection before they can arise.

Diagnosis.

In the first place the different varieties of epithelial tumours need to be distinguished from one another, though this is often difficult if not impossible. The following table summarises the chief differences found:

	Benign papilloma.	Malignant papilloma.	Infiltrating epithelioma, fungating, ulcerating.
Hæmaturia	Small amounts	Large amounts	Absent or little and late.
Attacks intermittent	Over periods of years	Over months	No relief after onset.
Growth	Slow, 2–10 years or more	Rapid, 1–3 years at most	Slow, 3–5 years.
Pain	Absent throughout	Not till late (dragged ureter or "corked" urethra)	Onset symptom, severe and persistent bladder cramp and infiltration of pelvic nerves.
Age	30–40 years	Over 40	50–60.
Per rectum	*Nil*	Bimanually under anæsthesia the bladder can be felt full of soft growth	A dense, hard plaque set in base of bladder felt at once.
Cystoscope	Single, above and to outer side of ureter; small; always fimbriated, never smooth	Often multiple, away from base; large; may be fimbriated, may be smooth	Single at base; ulcer with raised winding edges; floor covered with phosphates surrounded by distended glands, like green grapes, perhaps covered with exuberant masses of soft growth, which can be scraped away.
At operation	Firm pedicle, which can be stretched and freely moved on underlying muscle coat	Thick, stiff pedicle, which cannot be stretched and cannot be moved about on muscle coat	Hard, rolled-edged ulcer with hard base, invading surrounding tissues.

Diagnosis from other Conditions.

Painless hæmaturia may occur in young men from prostatic congestion induced by venereal disease or sexual excess.

In old men over fifty it may be produced by the congestion of an enlarged prostate alone, or in conjunction with a painless stone fixed in the post-prostatic pouch.

In women a urethral caruncle is a common cause of hæmaturia and is easily excluded.

Malignant disease of one kidney may give rise to hæmaturia, the origin of which can usually be determined by the cystoscope, but if secondary deposits in the bladder-wall have occurred by descent in the stream of urine the diagnosis may be very difficult. In such cases there is usually a deposit in the mouth of the ureter itself, whereas in primary papilloma of the bladder the growth surrounds, but does not grow in, the mouth of the ureter. The kidney may be felt enlarged, but even this may be mistaken for a hydronephrosis caused by growth obstructing the ureter. Fortunately these cases are extremely rare.

The hæmaturia of granular kidney can be distinguished by the cystoscope, and by noting the raised general blood-pressure.

The cases that are ushered in by pain have to be diagnosed from vesical calculus, vesical tuberculosis, and carcinoma of the prostate. Careful rectal examination, urinalysis, and, if necessary, cystoscopy, should enable a correct view to be taken.

It is well to remember that cases of sciatica, pain along the inner side of the thigh (obturator nerve) and in the hip-joint, and pain in the lower part of the back may be induced by infiltration of the pelvic nerves with cells of a bladder growth. Pelvic examination should be a routine measure in such cases.

Prognosis.

The duration of life after the onset symptom is most variable, the average being about three years, but it is very difficult to say in any particular case how long the course is likely to be. Some bladder tumours kill in a few months, others grow slowly and may be present from ten to twenty years before the fatal ending. If left to themselves they invariably lead to death sooner or later, but it is sometimes astonishing to find how long the patient may linger on, even though his agony be intense and his bleeding continual. One-sided renal pain is of grave significance, as it points to pressure on one ureter and the risk of pyelo-nephritis. Pain in the sacrum or down the thigh means that the disease has passed beyond the limits of the bladder and is inoperable.

After operation the prognosis is far from good, but it is of course much better than without operation. This was probably due in the past to late or faulty diagnosis, the rule being neglected that *hæmaturia demands immediate cystoscopy,* and also to insufficient or unsuitable operations having been performed.

In Watson and Cunningham's book on 'Diseases and Surgery of the Genito-Urinary System' is given a very complete list of figures based on 679 cases gathered from the literature up to the year 1907, to which the reader is referred if he wishes to pursue the subject, but such a collection of figures gives an inaccurate idea of the results obtained by the most experienced surgeons using the most modern methods of diagnosis and operative technique.

Watson found that the operation mortality for excisions of benign papillomata was 10 per cent., for partial resections of carcinomata 21·8 per cent., for total extirpation of the bladder 50 per cent.

Recurrence after operations considered radical was for papillomata 29·7 per cent., for carcinomata in partial resections 58 per cent., in total extirpation 12·5 per cent.

The percentage of non-recurrence was for papillomata up to three years 75·7 per cent., after three years 20 per cent.; for carcinomata after partial resection it was 10 per cent., after total extirpation 12·4 per cent. The known cures after all things considered was for papilloma 20 per cent., for carcinoma 6·8 per cent.

The results reported to the Second Congress of the International Society of Surgery, Brussels, September, 1908, are of interest.

Rovsing reports 80 operations for carcinoma of the bladder: 54 were ablations of mucous membrane and pedicle and 7 remained cured after five years; 5 were resections of the bladder-wall, of whom only 1 remained free from recurrence for one and a half years, 1 for one year, and 2 are still under observation eleven months and six months after the operation; 3 were total cystectomies and all have died from recurrence within the year.

Legueu reports 10 cases of ablation of the pedicle only and all showed recurrence; 2 cases of partial resection with recurrence in both.

Hartmann reports 8 cases after ablation, 4 without recurrence; 9 cases of partial resection with recurrence or early death in all.

Ribera y Sans, of Madrid, reports 5 cases treated by extirpation ; death occurred within six months in all.

Treatment.

Palliative.

1. *To stop hæmorrhage.*—Rest in bed for a day or two with the exhibition of urotropin and Contréxeville water usually suffice ; ergot is a useful drug, as is also aluminate of iron, but iron salts must not be allowed to constipate for fear of inducing pyelitis.

Lavage had better be avoided owing to the risk of setting up pyelitis, but if the bleeding be severe it can be controlled by washing out the bladder with silver nitrate in water, two grains to the pint, at a temperature of 115° F., or a hot solution of adrenalin 1 : 100,000 may be used.

2. *To remove clots.*—A large evacuating tube should be passed and suction applied by means of a Bigelow's evacuator.

3. *To prevent or diminish infection.*—Unnecessary instrumentation and lavage must be avoided, constipation prevented, a blocked ureter or urethra remedied, and urotropin and other urinary antiseptics exhibited combined with copious draughts of water.

Lavage with silver nitrate solution 1 : 10,000, or mercury oxycyanate 1 : 5000 may be of benefit in obstinate cases.

4. *To diminish pain and spasm.*—Infection should be warded off, but the pain may be due to involvement of the walls of the bladder or pelvic nerves by growth, in which case the resources of the practitioner will be taxed to the uttermost.

The milder analgesic drugs such as antipyrin and aspirin should first be given a trial. If these fail belladonna and morphia should be pushed till they control the condition. The local application of morphia and belladonna by the rectum or of cocaine to the bladder itself may be of some benefit.

In severe cases the bladder-walls may sometimes be quietened by supra-pubic drainage, or by deviating the stream of urine by means of ureterostomy or nephrostomy.

Operative Treatment.

The first fact to remember in dealing with the subject is that in all cases the disease is invariably fatal if left to itself. Benign papillomata will eventually bleed the victim

to death, and malign tumours will kill in various ways, so that cure apart from operation cannot be looked for. The difficulty of urging operation upon the patient consists in the fact that so far the published results are not very hopeful as to cure even by operation. It is true that if a benign papilloma be found cure may be expected in perhaps 60 per cent. of the cases; but far more often a malignant condition is found, in which case cure cannot be hoped for in more than 10 to 20 per cent. at the very most. If, however, the brilliant results obtained in isolated cases and by certain operators be considered the outlook is not so gloomy.

The reasons for the bad results of the past are as follows:

1. *The vital importance of hæmaturia as a symptom has not been recognised.*—The first attacks of hæmaturia are so slight, so painless, and recur at such long intervals that both patient and doctor are inclined to let the occasion go by. *Hæmaturia means cystoscopy* just as certainly as vaginal bleeding means vaginal examination.

2. *For this reason the surgeon has only obtained his cases late in the past.*—In the future he may hope to obtain them earlier and get increasingly good results.

3. The difficulty of deciding even at operation as to whether a pedunculated tumour should be treated as benign or malignant.

4. The tendency of apparently benign papillomata to recur locally and to infiltrate deeply after months or years.

5. The difficulty of knowing how far the bladder-wall is infected, and how much to remove at operation without a complete microscopical examination.

If these cases could be obtained in the early stages the results should be good, as the natural course of the disease is long for malignant disease, and secondary deposits seem to appear late if at all, and in the cystoscope the surgeon is provided with a weapon that renders early diagnosis comparatively easy.

The important points to realise are as follows:

1. Tumours of the bladder are far more often malignant than benign.

2. *Points in favour of malignancy* are—a patient over forty years of age—a short history—the presence of pain—a hardness in the bladder-wall felt by the rectum or vagina—multiplicity—a smooth surface—a white phosphate-covered surface surrounded by distended grape-like glands. *At operation*—a stout, stiff, hard pedicle. *Points in favour of a benign*

tumour are—a young patient—a long history—absence of pain—nothing to be felt in the bladder base—a single tumour which is pink, translucent, and fimbriated—a pedicle which is thin and can be stretched at the expense of the surrounding mucous membrane—and finally a microscopic examination of the pedicle.

3. The wall in the region of the tumour is far more extensively invaded by cancer-cells than digital examination would lead one to believe. Even the margin of one inch usually left around the limits of the tumour in performing partial cystectomy is probably too small.

4. There is considerable risk of infecting any raw surface with growth either in the parietal or vesical wound.

5. The whole mucous membrane of the bladder must be carefully inspected at the time of the operation for fear of missing any tiny papillomata.

The difficulties that make it hard to improve the results are as follows:

1. So many of the growths are near the ureteric orifices, where it is difficult to perform a radical operation.

2. It is difficult to persuade a patient of the seriousness of his condition and to submit to an operation which may entail the wearing of a permanent urinal.

3. Except in the hands of experts the operations are in themselves difficult and dangerous owing to hæmorrhage, shock, risk of infection, and fistula.

Nevertheless the results will certainly be improved in the near future.

1. Exploratory operation will be earlier performed and the completeness of removal will be greater.

2. Cases will be watched more carefully for recurrences by means of cystoscopy at regular intervals.

3. Improvements in the technique of ureterostomy and of supplying adequate urinals will render the radical operations less unpleasant in their after-results and patients will be persuaded to submit to them earlier.

The following operations do not give satisfactory results: (1) Removal by the operating cystoscope. (2) Removal through a perinæal cystotomy wound.

Operations that may be Performed.

1. *Supra-pubic cystotomy* with submucous ablation of a pedicled tumour.

2. *Partial cystectomy* (extra- or intra-peritoneal), with or without implantation of one ureter into the bladder at a fresh spot.

3. *Total cystectomy* combined with a *preliminary* double ureterostomy or nephrostomy.

4. *Palliative,* supra-pubic cystotomy, double ureterostomy or nephrostomy.

Indications.

Submucous ablation suffices for a single small papilloma with a delicate elastic pedicle.

Partial cystectomy suffices for a stout-pedicled or sessile tumour which lies on the lateral or anterior wall; or even which surrounds one ureter combined with cysto-ureterotresis; or for a pedicled papilloma which persistently recurs after ablation.

Total cystectomy is reserved for those cases, not very common, where the tumour is clearly malignant, but involves too large an area of bladder-wall for partial cystectomy, and also for those cases where papillomata are multiple, scattered all over the bladder-walls, and threaten life from repeated hæmorrhages.

Contra-indications.

1. If the growth can be felt as a hard, fixed mass infiltrating the base of the bladder and the surrounding structures.
2. If there is pain along the pelvic nerves.
3. If there is definite evidence of secondary deposits in glands or viscera.
4. If there is severe cysto-pyelitis.
5. If there is renal inadequacy.
6. If the general condition of the patient is not such as to warrant the performance of a severe operation which will throw great strain on the cardiac, respiratory and vaso-motor centres.

Such cases can either be left without operation, and may sometimes linger on for some years, though seldom without intense discomfort and pain, or an effort may be made to give rest to the bladder and drain the infected areas by means of a permanent supra-pubic cystotomy opening or a ureterostomy. Supra-pubic cystotomy combined with a thorough curettage of an exuberant growth, the wound being allowed to heal after a few weeks' drainage, will often bring intense relief for nine months or a year by giving relief from hæmorrhage, retention and cystitis, and is always worth considering.

Operations.

1. *Submucous Ablation.*

The bladder is opened by the usual supra-pubic incision and its mucous surface thoroughly explored for multiple papillomata. The base of the papilloma having been found thin and supple is caught up in a pair of curved pressure forceps, and the mucous membrane of the bladder pulled upon so as to make a considerable fresh pedicle on the bladder side of the forceps. The pedicle is then cut across at least half an inch from the forceps and the tumour removed. The wound thus left is stitched up with fine catgut, one or two deep stitches being applied if hæmorrhage prove troublesome. If this fails to stop the bleeding a caisson is passed down on to the wound, the surface dried with sponges, and pressure applied with a sponge wrung out of hot solution of adrenalin. If this fails to stop the hæmorrhage a pair of pressure forceps may be left on for twenty-four hours. Drainage by means of a supra-pubic tube should be maintained for a few days, and the wound can then be allowed to close, which it does readily.

The patient drinks freely of water and takes urotropin regularly, and the bowels are kept freely moved.

The Mayo's have urged lately that even for simple papilloma the bladder should be freely exposed by an intra-peritoneal operation so as to enable the walls to be brought up firmly into the wound and the pedicle be adequately dealt with.

2. *Partial Cystectomy.*

If a sessile or thick-pedicled tumour be found on the lateral or anterior walls—a rare contingency—the wall is bared by stripping it with the fingers and the tumour is freely cut out, the cut passing straight through the bladder-wall at least one inch from the edge of the tumour. The bladder-wall is repaired with catgut sutures after the hæmorrhage has been controlled and supra-pubic drainage is established. The immediate results of this operation are very encouraging, but opportunities for performing it are rare. It remains to be seen whether recurrence is the rule or the exception. The operation may be performed extra- or intra-peritoneally. So long as the bladder is not infected there is no risk in opening the peritoneum and exposing the bladder-wall freely. The Trendelenberg position is adopted and the intestines are

packed off from the field of operation with gauze pads or flat sponges.

If the growth surrounds the ureter, a sound may be passed up the ureter, the bladder-wall cleared all around, the growth and lower end of the ureter cut out, and the cut end of the ureter be implanted into the bladder afresh. The end of the ureter must be split a little and the two flaps united to the mucous membrane of the bladder with fine catgut.

3. *Total Cystectomy.*

This operation is very gradually coming into vogue, as it is becoming realised how inadequate the older partial operations have proved. It is rendered feasible by the improvement in the technique of ureterostomy, and the improved apparatus that can be designed by the instrument makers to catch the urine at the fistulous openings, such as those designed by Watson, and also by the fact that surgeons now perform the operation in two stages, doing a preliminary ureterostomy first, and employ spinal anæsthesia, both of which steps diminish the shock.

The question as to whether it is better to perform double nephrostomy or ureterostomy is still in doubt. Watson, and, to a less extent, Albarran, are in favour of nephrostomy, saying that the mortality after nephrostomy from ascending infection is less than after ureterostomy, and that the shock of the operation is less, whereas the risk of stricture and infection after ureterostomy is greater. These statements are not founded upon sufficient data to be final, and the results of further operations by Rovsing's method of ureterostomy must be awaited. The risks of stricture and infection have been exaggerated, and the gain to the patient of being able to see and look after the fistulous openings himself and the presence of a raised papilla render the task of supplying and maintaining a satisfactory urinal a much easier one.

The ureters have been implanted elsewhere than on to the skin, as in the vagina, the urethra, and into the colon or rectum. None of these methods have proved satisfactory. Either the risk is greater, or it is impossible to keep the patient dry.

A considerable improvement, therefore, is to be looked for in the results of operative treatment of malignant disease of the bladder in carefully selected cases, *but the practitioner must not neglect the danger signal—a slight hæmaturia.*

CHAPTER VII.

DISORDERS OF BLADDER FUNCTION.

After the completed act of micturition the bladder is empty, the walls being retracted to their full extent. As urine flows in from the kidneys the walls gradually relax to accommodate the fluid, so that the internal pressure remains at a constant level. The extent to which the walls can relax depends on the individual bladder, and whether its walls are healthy or in a state of sclerosis. At any time if the attention of the brain is called to the bladder a feeling or a desire to evacuate the bladder may be induced, which can be set aside by an act of will if the attention be removed from the bladder; but at last a condition is reached when the walls have relaxed to their fullest extent, and they begin to undergo slight tonic contractions. If the call be neglected hypogastric pain is felt, continuous and spasmodic, and at last the desire becomes uncontrollable.

The call to micturate is very largely a matter of habit. The bladder can be trained to retain water for many hours, or it can be made to fall into bad habits through nervousness, and ability to gratify the desire readily and often. Urine of high density containing much pigment and uric acid in suspension can often be held for hours, whereas urine of low density may have to be passed every half an hour. Various foods and drinks have a profound influence. The urine secreted during the morning and under the influence of hard mental work is far more irritating to the bladder than that secreted during the evening and night and during hard work in the open air. Women can hold their urine for a very much longer time than men, owing to the small amount of water that they secrete in the twenty-four hours, and from a good habit.

The act of emptying the bladder is a reflex act co-ordinated by the nerve-centres in the lumbar swelling of the spinal cord, which centre is controlled and inhibited by connection with the central cortex and the higher cells of the brain.

The muscles of the bladder consist of two sets:

(1) The detrusor set, consisting of longitudinally and circularly disposed smooth muscle-fibres.

(2) The sphincter set, consisting of the muscles of the trigone and the circularly disposed smooth muscles at the entry of the prostatic urethra.

The muscles are under voluntary control within certain limits—that is to say, the whole complex act of micturition can be set going or inhibited by means of voluntary impulses descending from the brain, but beyond a certain limit the brain ceases to be able to control them, and micturition becomes involuntary and forced.

In addition there is a voluntary muscle which can be used as a sphincter of the bladder, the compressor urethræ, and a set of voluntary muscles which can be made to empty the bladder by increasing the general abdominal pressure, namely the muscles of the belly-wall and the diaphragm.

The involuntary muscles of the bladder are supplied by two sets of nerves:

(1) Sympathetic fibres from the hypogastric plexus which run out from the cord along the lumbar nerves.

(2) Sympathetic fibres from the sacral plexus which run out along the second and third sacral nerves—"the nervi erigentes."

Stimulation of the hypogastric nerve-endings produces inhibition and relaxation of the detrusor fibres and contraction of the sphincter fibre. Stimulation of the nervi erigentes produces inhibition and relaxation of the sphincter and contraction of the detrusor.

During the act of micturition the sphincter is relaxed, and the detrusor contracts. The act can be stopped voluntarily by contraction of the compressor urethræ till the inhibitory impulses to the involuntary muscles have time to act, or is stopped involuntarily by disease of the co-ordinating nervous mechanism.

If the spinal cord be divided above the lumbar swellings, in dogs and sometimes in man a condition arises of automatic emptying of the bladder every few hours, or "flush-tank" action. After the bladder has filled to a certain degree of distension the lumbar reflex is set going and the bladder empties itself completely apart from consciousness, and in the intervals there is no incontinence. If the spinal cord be destroyed in the region of the lumbar swelling, retention with overflow is the rule.

Quite apart, therefore, from urethral obstruction the bladder may be unable to empty itself—

1. From disease of the nervi erigentes or their central connections in the cord.

2. From disease of the muscle-fibres of the detrusor.

When the bladder is unable to retain more than a few ounces of urine a condition of true incontinence arises, which is usually produced by paralysis of the sphincter, combined with unimpaired action of the detrusor, due to disease of nerves of the hypogastric plexus and its lumbar connections.

1. Nervous Disorders.

Paralysis of the nervous mechanism may be on the mental level, as is seen in hysterical retention, and in the inability of some persons to start micturating if they know they are being observed; on the cortical level, as in the case of brain injuries, hemiplegias, dementias, cerebral tumours, etc., on the cord level, either above the lumbar swelling when a condition of automatic bladder may appear, or in the lumbar swelling when retention with overflow is seen as in cases of injured spine, infective myelitis, disseminated sclerosis, hæmorrhage round tumours, and, on the sensory side, tabes dorsalis.

The paralysis may be complete or incomplete. If the sphincter is intact but the detrusor paralysed there is retention with overflow; if the reverse there is a true dribbling incontinence; if both are paralysed there is a partial retention with passive incontinence caused by any increase in the abdominal pressure produced by the action of the diaphragm and the muscles of the belly-walls.

In all cases it is necessary to determine whether the bladder remains empty, whether there is retention of urine, partial or complete, whether there is residual urine, habitual or intermittent, and its amount, and whether incontinence is due to retention with overflow or is a true incontinence.

It should never be forgotten that disordered bladder function may be the first or onset symptom of disease of the nervous system, especially of tabes and of disseminated sclerosis. The latter is met with chiefly in women in the third decade of life, the former in men in the fourth decade who have had syphilis.

Obscure bladder symptoms in adults in the absence of any sign of local disease in the urethra, bladder or kidneys should always call for a minute investigation of the nervous system.

Bladder States in Tabes Dorsalis or Locomotor Ataxia.

One of the first and often the very first sign of tabes may be a bladder that works badly, accompanied or not by painful bladder crises.

Tabes is produced by a degeneration of the synaptic endings in the cord of the peripheral sensory nerves (Theodore Thompson), the predisposing cause being syphilis, the exciting cause being excessive nervous strain. It is met with in males from the age of thirty onwards, and a large number of the cases fall first into the hands of the genito-urinary surgeon. All other signs may be lacking, but the early symptoms that should be looked for include delayed sensation in the limbs, absent knee-jerks, Romberg's symptom, lightning pains, crises, painless effusions into joints, Argyll-Robertson pupil.

1. *A bladder crisis* begins suddenly towards the end of micturition as the last drops of urine are squeezed out with an intense cramping pain felt in the urethra and at the end of the penis. The pain passes off in a few minutes, but in a short time the desire to micturate comes on again and the attack is repeated. The intervals between the attacks may be only a few minutes, or be hours or days. The pain is usually so intense as to double the patient up and cause him to cry out in agony.

These pains presumably take origin in the dying neurons, and as degeneration becomes complete the pains pass away for good and do not return; the patient then passes into the second stage of painless paralysis. These crises are the exception rather than the rule in tabetic cases, and the patient often has little if any pain from the first onset.

2. *Alterations of function.*—In the early stages the coordination of the act is interfered with; the sphincter hesitates to relax as the detrusor contracts, so that sudden interruption of the stream occurs, or the urine drips away slowly.

The next stage is a partial retention of urine with increased frequency of micturition. The detrusor becoming relatively insufficient, the bladder is neither very full nor ever completely empty, a residual of some six to twelve ounces being removed by catheter. This stage gradually passes into one of complete retention with overflow and apparent or false incontinence, but as the sphincter is relaxed the mere act of coughing, or any slight straining movement, may produce a dribble of water.

In considering diagnosis the nature of the nerve-lesion

must be determined and suitable treatment applied, especially if there is a syphilitic taint, and the exact condition of the bladder must be investigated. In the first place it is necessary to determine whether there is any residual urine, and if so how much; in the second place, whether there is any cystitis with ulceration or stone formation, as local treatment depends on these findings. The patient is asked to pass his water, and then the bladder is examined by palpation, abdominal and rectal, to feel if it still contains urine, the urine being tested in the usual manner. If the bladder can be felt to be nearly empty and the urine is clean nothing further should be done. If the bladder is not empty, and especially if the urine is purulent, further steps must be taken. A catheter is passed, the bladder emptied, the amount of residual urine estimated, and cystoscopy is performed if a stone is suspected. In carrying out instrumentation of a neuropathic bladder the most minute precautions must be taken to secure asepsis, as the risks of setting up cystitis and ascending pyelitis are multiplied ten-fold owing to the lowering of resistance on the part of the denervated tissues. The penis is washed with soap in weak lysol solution, the urethra irrigated freely, the hands of the surgeon are scrupulously cleaned and clothed in sterilised gloves, the instruments and lubricants are rendered sterile.

If a considerable quantity of residual urine is found, which is causing nocturnal incontinence with wetting of the bed and disturbance of sleep, the best course to pursue is to pass a catheter every night at bed-time and empty the bladder, when the nocturnal incontinence should cease. During the day-time the patient can often keep his bladder fairly comfortable and refrain from soiling his dress as long as he still has conscious warning of micturition and his belly muscles are acting well.

If the urine be infected, not only must the kidneys be flushed out with copious drinking of fluid and urinary antiseptics (urotropin, etc.), but lavage had better be instituted after the nightly catheter. The best solution to use is oxycyanate of mercury in strengths of 1 in 6000 to 1 in 2000, and after a week or so of lavage the urine should become clean in the absence of pyelitis.

The chief drugs of service are nux vomica and ergot; given empirically they certainly do good. Electrical treatment should be tried, the tri-phase current applied directly over the bladder region of the abdomen being the most effectual.

2. Atony of the Bladder.

Loss of bladder-power may be due to disease of the muscle-fibres themselves rather than the nerve supply. A state of atonic relaxation is produced which may be complete, so that there is passive distension of the bladder with continual passive overflow, or incomplete, the muscle-fibres being unable to retract to their full extent.

Atony of the muscle-fibres is produced by the following causes:

1. *Mechanical over-distension:*
   —after a single acute unrelieved retention.
   —insidious onset from chronic back-pressure.
2. *Poisons acting on the muscle itself:*
   —acute specific fevers, especially typhoid and influenza.
   —chronic cystitis (diffuse fibrosis of the wall).
3. *Poisons acting on the nerves supplying the muscles:*
   —belladonna and morphia.
   —lead and carbon disulphide.

It was once held that if the muscle of the bladder became atonic no recovery of tone would take place. From observations on the end-results of prostatectomy it is becoming increasingly clear that recovery of tone can be expected and may be complete if the cause is removed, especially if the cause be urethral obstruction. Drugs such as ergot and nux vomica are useful adjuvants, and the muscle can be exercised by applications of the tri-phase electric current to the hypogastrium.

3. Incontinence of Urine.

Incontinence may be true or false.

False incontinence is common and is caused by *retention of urine with overflow*, the causes being those of retention of urine, urethral or vesical.

True incontinence may be active or passive. Passive incontinence is said to be present when the sphincter of the bladder is relaxed and urine dribbles away from the urethra as fast as it flows in from the kidneys—an extremely uncommon state of affairs. Active incontinence is very common in children but is seldom seen in adults.

CAUSES OF INCONTINENCE.

A. *False,* causes of retention (see p. 402).
B. *True.*

1. *Active = irritation of detrusor muscle and its nerves.*
   — irritation of phimosis, calculus, rectal parasites or polypi, uterine disorders (adenoids ?).
   — defective development of co-ordinating fibres in the nervous system.
   — psychic, habit, anxiety.
   — neurasthenia, phosphaturia, low density urine, onanism.
   — irritation from cystitis.
2. *Passive = relaxation of sphincter.*
   — epilepsy.
   — injury to the nervi erigentes (third and fourth sacral nerves).
   — congenital defect of sphincter as in epispadias.
   — small contracted "thimble" bladder in chronic tuberculosis of women.
   — impacted calculus.
   — rare varieties of enlarged prostate.
   — in children and women after operations on the perinæum and urethra which have over-stretched the sphincter or damaged its nerve supply.

When faced with a case of incontinence the practitioner should endeavour to class it under one of the above categories.

The so-called incontinence of children is an involuntary automatic act of micturition, and is a sign of an inadequately adjusted nervous system. All children are incontinent at birth and for a year or two afterwards, but by degrees the higher centres gain control over the lumbar cord centres, and the act can then be inhibited to suit the requirements of civilised life. In those who are mentally deficient the act may never come under brain control, and on the other hand in those of neurotic stock there may be delay in the complete adjustment of the upper to the lower centres, the affection being a sign of a highly strung nervous system.

Incontinence may thus occur up to the age of puberty in children of either sex every few nights or every night, or by day as well as by night.

In many cases some local cause of irritation can be found, and its removal when feasible will completely cure the condition. Examination should therefore be made for phimosis, vulvitis, calculus, bacilluria, glycosuria, rectal parasites or polypi and such-like local causes, and also for disease of the nervous system such as mental deficiency, epilepsy, spina bifida, Pott's disease, etc.

If these can be excluded the case comes under the group of "essential" or "idiopathic" incontinence. Such cases may be due to undue excitability of the bladder mucous membrane, to indifference of the sphincter, or to the influence of mental worry and dreams induced by the reproaches of parents and nurses.

Procedure.

Mental treatment is the first essential. The child should be taught that the disease is no disgrace, that the parents are convinced he cannot help it, and do not look upon him as an outcast. Great care should be taken to see that the nurses are not worrying the child behind the parents' back, and he should be told that he will soon grow out of it. No fluids should be given after 6 o'clock in the evening, and tea and coffee or alcohol at any time should be interdicted. The child should be put to sleep in a room with open windows, and a night-light should be kept burning. The mattress should be firm and be protected by a mackintosh, the blankets light, and the child should be taught to sleep on the right side and not on the back, and should be waked after four hours and made to empty the bladder.

In the day-time the general health should receive close attention, the nervous system being built up by means of good food, exercise in the open air, and adequate rest, and protected from over-stimulation and worry of prolonged lessons and tasks. The throat and alimentary system usually require attention.

As regards treatment directed to the urine and bladder, it is often of advantage to try changing the reaction of the urine for a time. If it is highly acid render it alkaline by doses of potassium citrate, if it is alkaline render it acid with acid sodium phosphate, and it is well to make sure that there is no bacilluria.

If the bladder is unduly sensitive excellent results can be obtained by the exhibition of belladonna. The tincture is used in doses of five minims three times a day, the dose being worked up over a period of three weeks to as much as thirty or even forty minims. Careful watch must be kept for signs of poisoning, such as flushings of the conjunctivæ, rapid pulse, slow respirations, giddiness and delirium, but dryness of the throat and skin and dilated pupils must be expected in any case. A six weeks' trial should be made of this treatment, and if it is successful it may be repeated after a short

rest. If it fails other sedative drugs may be tried, such as hyoscyamus, the bromides, antipyrin, aspirin, chloral, etc., but they are not likely to succeed when belladonna fails. Instillations of strong silver nitrate (1 per cent.) sometimes prove efficacious by diminishing the sensibility of the neck of the bladder.

Electrical treatment is disappointing.

Albarran and Cathelin have advocated an attempt to diminish the excitability of the nervi erigentes which bring about the act of micturition, using intra-dural injections of various substances in the coccygeal region. They have obtained the best results with 10 c.c. of normal serum given every second night for eight days, but success is not by any means universal. The method is worth a trial.

In obstinate cases suggestion has a powerful influence, but its employment is not unattended with other disadvantages, and should never be undertaken lightly.

Leonard Williams has recently reported considerable success from the exhibition of thyroid extract.

CHAPTER VIII.

BILHARZIA HÆMATOBIA.

THIS disease has assumed a certain importance in England since the occupation of Egypt and South Africa by English troops, as it may be the cause of a painless or painful hæmaturia.

The symptoms are produced by the passage of the eggs of a parasite through the walls of the bladder. The characteristic symptom is the passage of a few drops of blood at the close of the act of micturition, apart from which there may be no other sign that anything is wrong.

The patient may notice a tickling sensation in the urethra, and that the frequency of micturition is increased.

Secondary infection with bacteria will give rise to a painful cystitis and the formation of stones in the bladder, and to pyelonephritis, but these complications are hardly ever seen in the cases in England.

The diagnosis rests upon three factors:

1. The history of a residence in Egypt, Arabia, or South Africa.
2. The finding of the eggs of the parasite in the urine by microscopic investigation of the last few drops passed.
3. The cystoscopic appearances.

Patches in the bladder-wall are seen with the cystoscope dotted over with brilliant white spots, surrounded by healthy mucous membrane or by velvety hyperæmic areas, the white spots being the tails of the adult worms seen through the mucous membrane.

The eggs are about one tenth of a millimetre long and are ovoid in shape with a spine at one end. They consist of an outer shell surrounding a ciliated embryo or "miracidium." If placed in fresh warm water the miracidium hatches out. The embryo perishes in one or two days, and is killed at once by dryness or cold. There is no intermediate host, but the embryo appears to enter a fresh human being again directly, either making its way through the skin of the legs into the blood, and so to the liver as Looss holds, or directly up the

urethra as Dr. Allen, of Natal, maintains. All are agreed that it does not enter in the drinking-water.

The adult worms develop in the portal veins of the liver, taking three to six months to attain maturity, from which they make their way to the pelvic veins, and having anchored in the bladder-walls they proceed to hatch out brood after brood of eggs. In this state they live on for three or four years when they die of old age, though exceptionally they have been known to live for many years longer. If, then, the victim leaves the infected country he may reasonably expect his parasites to die out in about four years' time, but the symptoms will usually disappear long before that.

The prognosis as regards life is excellent if reinfection can be avoided, though amongst the Egyptians themselves there is a small mortality from calculus and pyelitis.

Treatment.—Europeans in infected districts should avoid bathing in stagnant, muddy pools frequented by native children, and if Dr. Allen's hypothesis be correct circumcision or a careful drying of the meatus and foreskin after bathing is a certain prophylactic.

When the disease is established it has to be left to die out of itself, reinfection being carefully avoided.

Sandwith states that good effect may be obtained by the exhibition of the liquid extract of male fern in fifteen-minim doses three times a day for a fortnight, and any irritation of the bladder can be controlled by giving a methylene blue pill containing three grains twice a week.

If cystitis or calculus is present the treatment for these conditions must be carried out as already described.

SECTION IV.

DISEASES OF THE PROSTATE.

CHAPTER I.

FIBRO-ADENOMA OF THE PROSTATE ("ENLARGED PROSTATE").

Definition.

THE clinical term "enlarged prostate" has been loosely applied in the past to include several different forms of prostatic disease in men over fifty, but has not included several varieties of prostatic enlargement met with in men under fifty. The advance in pathology has rendered the term obsolete, though it will be long before it disappears from the clinical field.

Ætiology.

In one man out of every five who attains the age of fifty years trouble in urination arises sooner or later, caused by disease of the prostate gland. In 90 per cent. of the cases this disease consists in the formation of benign adenomatous tumour masses within the gland; in the remainder it is due to malignant disease, or to the fibrous prostate of chronic prostatitis.

The cause of the formation of benign adenomata in any part of the body is unknown, but it is a distinct step in advance to recognise that the common cause of enlargement of the prostate in men over fifty is benign tumour formation. The disease often appears in many members of the same family through several generations, but there is no proof that it is in any way inherited. Efforts have been made to prove that there are predisposing causes, such as sexual excess and

chronic gonorrhœal inflammation, but so far without a particle of real evidence.

It is true that chronic inflammation of the prostate can give rise to enlargement of the prostate, and may even lead to residual urine, but the disease is not limited to any age, is uncommon except in adult life, is not progressive, and can be cured by suitable treatment without an operation. Persons over fifty are not immune to such inflammations if they contract gonorrhœa at that age; and persons over fifty without venereal taint but with adenomatous prostates are liable to infection of the prostate with such organisms as the colon bacillus and staphylococcus, and to attacks of mild inflammation; but in such cases *the predisposing cause* is an adenomatous prostate; *the exciting causes, the bacteria, are secondary,* and are introduced on the catheter, or enter from the blood-stream. Such attacks of inflammation may play a part in causing intermittent attacks of complete retention in prostatics who in the intervals show comparatively little symptoms of disease; but they have nothing to do with the primary enlargement of the gland. The majority of adenomatous prostates reveal no microscopic evidence of inflammation.

Pathology.

Surgical Anatomy.

The prostate has been aptly described by comparing it to an apple. Take an apple, lay it on a table with the stalk upwards, and bore out the core. The tunnel represents the course of the prostatic urethra. Pass two hat-pins side by side through the apple from the outer edge of the upper surface to enter the core-hole in the centre of the apple. The pins represent the course of the ejaculatory ducts and their relation to the prostatic tissue.

The prostate consists of glandular tissue lying in a stroma of connective tissue and unstriped muscle-fibres. There is no true division into lobes. The outer limits of the gland are defined by a condensation of this stroma, which forms a false capsule for the gland. This has been termed the cortex of the gland, and contains comparatively few blood-vessels. The cortex is surrounded by an outer true capsule formed of dense fibrous connective tissue continuous with the pelvic cellular tissue or so-called pelvic fascia. This outer capsule contains the veins of the vesico-prostatic plexus. The cortex

can be enucleated from the outer true capsule except at three parts where it is densely adherent to the outer sheath —at the apex, at the anterior commissure, and along the superior lateral border. Enucleation of an adenomatous prostate may be performed between these two layers, and if it is the enucleation is difficult, has to be aided by the scissors, and bleeding from the prostatic plexus of veins is severe, owing to the division of these dense adhesions. Enucleation is more easily performed between the capsule of an adenoma and a false capsule formed by the pressed-out and condensed tissue of the rest of the gland.

Morbid Anatomy.

Benign tumours of the prostate are :

(1) Glandular.

(2) Fibromyomatous.

Both are fibro-adenomata and contain both gland-tissue and fibromyomatous stroma, but in the first the glandular elements predominate, in the second the elements of the stroma. Between the two extremes lie many intermediate forms just as in the case of fibro-adenomata of the breast. The fibromyomatous type is not common, and may consist of a small firm tumour which is encapsuled or may appear as a tough tumour-mass involving the whole of the prostate, around which it is difficult to demonstrate a capsule by enucleation.

A practical classification therefore is into—

1. Encapsuled tumours.
2. Diffuse or non-encapsuled tumours.

The encapsuled tumours are usually of the glandular variety, but may be fibromyomatous, whereas the diffuse tumours are confined to the fibromyomatous group. A false idea that the surgeon is dealing with a diffuse tumour is obtained in those cases where there are multiple small adenomata in an early stage of development, and an attempt is made to shell out the prostate gland complete aided by the scissors. The encapsuled glandular variety is by far the more common (97 per cent. Albarran, 86 per cent. Young). The practical point to remember is that in a few cases enucleation is difficult if not impossible if the diffuse fibromyoma be encountered.

On section of an affected gland in the early stages yellowish white perles are seen, paler and more homogeneous than the surrounding spongy gland-tissue. These perles can be enucleated with ease and may be single or multiple, or form a single

large mass made up of small tumours. As they grow they push the healthy gland-tissue aside, and compress it so that the glandular elements atrophy, leaving little else but flattened-out bundles of stroma-tissue. In this way an adenoma forms a capsule for itself, which consists of atrophied prostatic tissue and out of which it can be enucleated.

In the later stages a well-developed adenoma may consist of a single rounded mass, of two or three lobulated masses held loosely together and surrounding the urethra in the form of a crescent or a ring, or of multiple rounded masses forming an irregularly lobulated tumour. On section the surface of the adenoma closely resembles that of a normal gland, but it may be paler, more homogeneous, and firmer in consistency, or it may exhibit small cysts. A milky fluid can be expressed from the acinous spaces containing dark gritty bodies like grains of pepper.

As these tumours grow they push their way along the line of least resistance, either backwards towards the rectum, or upwards into the bladder *between the mucous membrane and the muscular coat of the internal sphincter.* When this occurs *on either side of* the urethra so-called "lateral lobes" are formed, when *behind* the so-called "middle lobe."

The microscopic appearances.—The outer capsule is formed of a dense network of fibrillar connective tissue interspersed with unstriped muscular fibres and a few flattened gland-spaces lined by pressed-out epithelial cells (atrophic glandular tissue). Inside this is the fibrous capsule of the adenoma which merges with the general sponge-work of the tumour itself, consisting of fibrillar connective tissue, unstriped muscle-fibre, and a few well-formed blood-vessels and surrounding numerous acini lined by epithelium. This usually appears as a single layer of columnar epithelium except in the spaces with large lumina caused by cyst formation, where it is cubical or flattened out. Papilliferous intra-cystic projections of stroma lined by epithelial cells are quite common. The lumina are filled with epithelial *débris,* large granular and fatty cells and a few leucocytes, or with homogeneous laminated secretion and corpora amylacea.

In the large number of cases there are no signs whatever of chronic inflammation, such as arteritis and the presence of crowds of leucocytes and plasma-cells in the connective-tissue spaces.

The fibro-myoma is an uncommon form, and may be

encapsuled or diffuse. It is pale, dense and homogeneous on section, and presents comparatively few glandular elements, the main mass of the tumour consisting of fibro-myomatous bundles and a few blood-vessels with well-formed walls.

The diffuse fibrous prostate.—The whole gland is little if at all enlarged, and is turned into a dense, tough mass of fibrous tissue that is firmly adherent to the pelvic fascial sheath and cannot be enucleated. On microscopic examination almost complete atrophy of the glandular elements is seen, their place being taken by a dense feltwork of fibrous stroma containing blood-vessels in a condition of advanced arteritis. It is doubtful whether this form should be included under benign tumours of the prostate, and should not rather be separated off as a distinct disease, the fibrous degeneration of the whole prostate being either the result of long-standing chronic prostatitis, or a primary senile atrophy of the parenchyma cells with secondary replacement fibrosis comparable to diffuse "chronic mastitis" in the breast.

The clinical separation of this group is of importance, as the prognosis and treatment are different to that of the adenomata.

Secondary changes in other organs (which produce the symptoms of the disease).

Changes in the urethra.—There is seldom much narrowing or compression of the urethra, which takes a No. 8–10 English scale catheter with ease, and widening may even occur owing to irregular lobulation of the tumour on either side of the urethra. Narrowing is a marked feature of the small diffuse fibrous prostate. As the tumour grows upwards into the bladder it raises the mucous membrane and carries the internal meatus with it, so that a real lengthening of the prostatic urethra is brought about. The curve of the prostatic urethra is altered, the lengthened channel forming a bolder curve or becoming S-shaped, and sometimes presenting lateral deviations from the middle line.

A fresh internal meatus is formed by the upward growth of the tumour beneath the mucous membrane of the bladder which assumes the form of an S, C, or Y. The internal sphincter of the bladder ceases to bear a direct relation to the meatus, tumour-tissue being interposed between the mucous and muscular coats. The intra-vesical lobular projections of the tumour, if well-marked, may act as valves when the bladder contracts, being forced down into the mouth of the meatus so so as to block it more or less completely.

The ejaculatory ducts in their fascial sheaths are forced backwards and downwards, and the glandular tissue that normally lies between them and the posterior surface of the prostate is pressed out into a thin fibrous sheet—a fact that is made use of in certain forms of perinæal prostatectomy.

Changes in the bladder.—The bladder-wall undergoes hypertrophy in all cases, but the size of its cavity and the apparent thickness of its wall depends on the state of the tone of the hypertrophied muscle. As tone is lost the muscle grows less and less able to empty the organ completely, so that the walls are stretched and the bladder capacity is increased to as much as thirty or forty ounces.

Hypertrophy of the muscle coat usually advances *pari passu* with the need for increased power and work, as shown by the increased thickness of the wall, which is honeycombed with trabeculæ and pouches, and the lessened internal capacity. Later on secondary changes are produced by the onset of cystitis and the formation of calculi. Chronic cystitis, if prolonged, causes a fibroid degeneration of the muscular wall, and renders the diminution in capacity more or less permanent, so that the bladder remains small, though tone is lost. In another form the capacity of the bladder is greatly increased, but the walls are thickened, and the muscle-fibre makes considerable efforts to overcome the obstruction, but for all this the bladder remains half full after each act of micturition.

Finally a form is seen where the muscle-fibre has lost all its tone and has given up work altogether. The bladder forms a coniform sac extending upwards to within a short distance of the umbilicus and covered with distended veins. The peritoneum may be carried away from the belly-wall as the bladder rises, but in many cases the peritoneum becomes adherent to the anterior wall of the bladder so that it is stretched rather than carried upwards, and a pouch of peritoneum is formed between the anterior wall of the bladder and the back of the belly wall, and in one case we have even seen this peritoneal pouch filled with coils of small intestine—facts to be remembered in the question of supra-pubic puncture. The wall itself is thickened and contains a well-marked layer of hypertrophied muscular fibres—that is to say, there has been a primary hypertrophy with secondary functional atony and relaxation of the muscle-fibres themselves. If chronic cystitis has existed it will have produced fibroid induration between the muscle-bundles. The engorgement of veins is produced

by the weight of the distended organ as it rests on the venous plexus around the neck of the bladder.

By the upgrowth of the tumour into the cavity of the bladder and the increased intra-vesical tension, certain large pouches are formed near the bladder-neck in addition to the small diverticula formed higher up in the bladder-walls. The best marked of these lies behind the prostate, the post-prostatic pouch, which cannot be emptied by the contractions of the bladder-muscles, so that it contains a stagnant pool of residual urine, a harbour for stones and collections of phosphatic *débris,* which invites bacterial onslaught. Stones get so firmly wedged and buried in this pouch that not only may they cause no pain but they may be missed even at a supra-pubic cystotomy.

Changes in the kidneys and ureters.—In a few cases there is very little change in these structures, but in the majority there arise dilatation and hypertrophy of the wall of the ureter and pelvis, the kidney substance becoming thinned, hollowed out, and fibrotic. In the later stages this fibrosis may be very advanced, and the blood-vessels be in a condition of chronic hypertrophic arteritis, the tubules being dilated and lined with flattened and degenerated epithelial cells. When infection has occurred, ascending or descending, the appearances peculiar to pyelonephritis are engrafted on the top of all this (see Ch. VII, Sect. I), the blood-vessels being engorged, and the connective-tissue spaces and tubules filled with exudation, pus-cells, and bacteria.

Remote changes.—Cardio-vascular hypertrophy and degeneration are seldom absent, being secondary to the renal changes. Hernia and hæmorrhoids are produced by the increased abdominal pressure in the forced efforts to micturate. A barrel-shaped chest with emphysema and chronic bronchitic changes in the lungs are very commonly met with, but these changes are associated with the time of life rather than with the disease.

Clinical History, Symptoms, and Signs.

The onset.—Three clinical types can be distinguished in accordance with the onset symptoms.

(1) The "Irritable Bladder" Type.

A robust individual between the ages of fifty and sixty is disturbed in the middle of sleep by an irresistible call to micturate, and has to rise and empty his bladder. This goes

on with few exceptions night after night, but gradually the calls grow more frequent, so that the sufferer has to rise four or five times to satisfy them, and sound sleep is banished. By this time he begins to notice that he has to pass water more often in the day-time, and that the call cannot be resisted for more than a few minutes; but, having reached a convenient place in which to micturate, he finds that he cannot start the flow as quickly as was his wont, that straining is not only of no avail but even detrimental to his chances, and that when the stream does appear it is a small one, or, lacking force, falls perpendicularly to the ground. This state of things he endures often for eighteen months or two years until an attack of retention brings him under observation.

(2) The "Painful Retention" Type.

A man of fifty or sixty, in the best of health, suddenly discovers that he is unable to pass his water. After a few hours he is taken with painful cramps in the hypogastric region, and an intense desire to pass water, but he can effect nothing, and, becoming alarmed, he sends for the doctor. A dose of morphia and a hot bath is all that is required to relieve the condition, though resort must be had to the catheter if this treatment fails, and the difficulty disappears for the time being, perhaps for six months or a year. These attacks are repeated at lessening intervals until the retention may become complete and permanent, so that regular catheterisation becomes an established necessity. They appear to be produced by a condition of congestion of the prostatic urethra and spasm of the sphincter apparatus, set up by the irritation of cold or alcohol, or by a mild bacterial invasion of the prostatic urethra. They are painful because the bladder-muscle is in good condition and able to undergo cramping contractions.

(3) The "Painless Incontinence" Type.

A cadaveric, wasted old man, who for some time has been afflicted with thirst and dyspeptic troubles, finds that he cannot hold his water for more than a few minutes, but that it dribbles away drop by drop, fouling his garments and debarring him altogether from society. For some time past he has been worried with "lumbago," so that he determines to seek advice, and is astonished when he hears that his bladder is full of water, as he imagines that he has been

emptying it every few minutes. If his bladder be emptied quickly and completely by a too hasty catheterisation he is very likely to be dead before ten days are out.

The condition is due to complete painless atony of the bladder-muscle with retention and overflow ("false incontinence"), and the "lumbago" is caused by back-pressure on the kidneys.

Symptoms and Signs.

Pain is more often absent than present during the first few years, a circumstance that keeps the patient from seeking advice as he finds it hard to believe that any other symptom can be serious if it is not accompanied by pain. Meanwhile irreparable damage is being slowly worked on bladder and kidney.

Pain when it does appear is due to various different causes.

Cramping pains felt above the pubes and along the urethra into the head of the penis are set up by the efforts of the bladder-muscle to overcome obstruction.

Similar pain but of increased intensity is set up by such complications as acute cystitis or calculus formation, though it must never be forgotten that a stone firmly pouched behind an enlarged prostate may be painless.

An aching pain in one or both "renal angles" in the back of the loin is due to back-pressure on one or both kidneys, and should not be lightly passed over as a "mere lumbago," but should be given its full value in prognosis. This pain becomes intense and the kidneys tender when infection has occurred.

Pain in the sacral region and down the back or inner sides of the legs may be due to the presence of calculi, but is far more often an indication that the disease is malignant and has passed beyond the limits of the prostatic capsule.

Micturition.—Nocturnal increased frequency of micturition in a man over fifty years old is *the* sign of an "enlarged prostate." The diurnal increase is often just as great but is not so noticeable to the patient. Many reasons are advanced to account for this phenomenon. In the first place polyuria is usually present, but whether it is caused by renal back-pressure changes or by the irritation of the prostatic nerves is hard to say. Some authors maintain that the mucous membrane of the prostatic urethra is drawn into the cavity of the bladder, and that contact of urine with this mucous membrane is the cause of the call to micturate. Others say that the

desire to micturate arises when the tension of the fluid within the bladder reaches a certain height, and that owing to hypertrophy of the muscle coat this point is reached with a lesser quantity of fluid than normal in the bladder of prostatics. When there is residual urine the increased frequency is easily understood, but residual urine is not always present in the early stages. The water may be passed every few minutes when there is cystitis or when there is complete retention with overflow. Another suggested explanation is that the tumour projecting into the bladder acts as a foreign body which the bladder desires to expel, but many foreign bodies lie quiet in the bladder for a long time and do not necessarily lead to increased desire to micturate. The tumour may press upon the sensory nerves that are concerned with the reflex emptying of the bladder, and irritate them into action.

The stream is altered in various ways; for instance there may be inability to start the flow, or the flow can only be maintained by kneeling or by some peculiar posture. The stream is small, of poor force, falling perpendicularly in a steady stream, or forced out drop by drop.

Inability to hold the urine for more than a few minutes after the call arises is often an annoying feature.

Incontinence from passive overflow is common, but true incontinence is exceedingly rare.

Partial retention or inability to empty the bladder completely is the usual condition found, so that a variable amount of residual urine is left. In the earlier stages this urine comes from the post-prostatic and peri-prostatic pouches, but in the later stages the larger amounts can only be explained by supposing that the muscle-fibres of the bladder have ceased to be able to contract to their full extent, and are in a state of partial atony.

Complete retention is often observed, temporary when there is congestion and spasm of the prostatic urethra, permanent when there is a valvular internal opening which the bladder muscle cannot force, or when the bladder-muscle gives up the struggle and becomes atonic. In the first and second groups there is intense pain which necessitates relief by a catheter; in the third group there is no pain at all, and catheterisation is not immediately required.

Retention is sometimes due to profuse hæmaturia with the production of clots—"*clot-retention*"—and is discovered when a catheter is passed and nothing is drawn off except a

piece of clot found in the eye of the catheter after withdrawal.

Attacks of complete retention come on at increasingly shorter intervals until at length complete retention becomes permanently established, and not a drop of water can be passed without a catheter. It is rare for the first attack of retention to remain complete but it does so happen, and particularly in malignant cases.

Loss of sexual power is the exception, whereas in neuropathic bladder troubles it is the rule, in fact it is often the other way, sexual desire being increased and becoming a source of trouble to the patient.

Hæmaturia is not common, but may be extremely profuse even in a case otherwise uncomplicated. The bleeding is generally said to come from the engorged veins of the mucous membrane of the bladder, but on exploration the bleeding point is often found to be a small artery, and the greatly raised blood-pressure is the predisposing cause. The clots may set up complete retention ("clot retention").

There is no reason to suspect malignancy when hæmaturia occurs, though in a few cases the hæmorrhage does prove to arise in a malignant ulcer of the prostate into the bladder—an uncommon condition. A pouched calculus may also set up painless hæmaturia.

The general symptoms are caused by back-pressure on the kidney with consequent fibroid degeneration, and are the signs of chronic uræmia (see Ch. I, Sect. I). Infection on top of this brings out symptoms of toxæmia, and increases those of uræmia by depressing the kidney function suddenly and profoundly (see Ch. VII, Sect. I).

The chief signs of *back-pressure* on the kidneys are an aching pain in both renal angles, polyuria, the passage of pale urine, a subnormal temperature, thirst and mild dyspeptic troubles. If a patient be examined at this stage his arteries are found to be thickened and his general blood-pressure is raised to 170–200 mm. of mercury. It is usually impossible to determine the state of the heart by percussion and palpation, owing to the emphysematous barrel-chest, though much can be gained by noting the rate, rhythm and strength of each pulse-beat and by listening to the sounds of the heart. If the rhythm is regular, the first sound clear and not too short, the second sound clear and ringing, it is reasonable evidence that the cardiac muscle is reacting well to the increased needs of the kidneys.

Prostatic patients with their emphysematous chests are liable to attacks of bronchitis, which become aggravated if the urine is ammoniacal.

The mental condition is excellent, and the nervous system unaffected until the very end, convulsive twitchings of the fingers being the first sign of danger. The pupils show no characteristic changes, and retinal changes apart from those of vascular hypertrophy are not found till the last stages.

Wasting and anæmia are only found when the kidneys are on the borderland of collapse from back-pressure or infection or both.

The onset of infection may be insidious or sudden. A swinging temperature chart is seen, and the patient wastes rapidly and sweats profusely. The urine becomes purulent and foul in spite of bladder irrigation, and gradually diminishes in quantity, while the uræmic symptoms develop more fully. The blood-pressure, which at the onset of the increased uræmic symptoms may have risen inordinately (220–250), sinks rapidly to a low figure (30–50 mm. Hg.), the patient becomes cyanotic and comatose, and some hours after the onset of complete suppression of urine he gradually sinks into coma, which may be preceded by general convulsions.

Physical Signs.

Abdomen.—The bladder may not be palpable, or it may form a definite, firm, elastic tumour extending upwards above the pubes to a lesser or greater extent and may reach to the umbilicus. The medium-sized bladders are met with in cases of painful retention, the large flaccid bladders in cases of painless incontinence or overflow.

The size of the bladder after micturition can be estimated by means of bimanual, rectal, and abdominal examination, and in this way a shrewd though rough idea as to the amount of residual urine can be arrived at amply sufficient for practical purposes. The fixed idea in the minds of the profession that it is of vital moment to estimate the exact number of ounces of residual urine cannot be too strongly condemned. In most text-books the practitioner is instructed to estimate the residual urine by passing a catheter. We venture to lay it down as a law of practice that *no catheter should ever be passed with the sole idea of estimating the residual urine,* and that there is no need to pass a catheter at all in many cases. The *catheter is only to be used for purposes of* TREATMENT *in suitable cases that need it, never solely for* DIAGNOSIS. The catheter has been the curse

of prostatic surgery, and its use is attended with a higher mortality than that of prostatectomy. It is especially the first catheter that is so dangerous, if it is passed without any previous precautions in the consulting room or out-patient department (see below under "Treatment," p. 343).

If a catheter has to be passed to relieve painful retention of urine there will be noticed an increase in length of the prostatic urethra and alterations in direction, to overcome which special instruments of increased length and of special curves may be required.

Rectal examination.—This is best carried out with the bladder empty. The patient is asked to micturate, but if residual urine is left the surgeon must remain content, unless there is some valid reason for passing a catheter. Using the utmost gentleness to avoid bruising the hæmorrhoids almost invariably present, the surgeon inserts a gloved finger lubricated with vaseline into the rectum, taking note of the condition of the sphincter, which if flaccid at once suggests nervous disease, and examines the posterior surface of the prostate, vesiculæ, vasa, ureters, and base of bladder. The condition of the pelvic cellular tissue is noted, but the regional lymphatic glands are usually too high up to be felt except the small sacral group in the meso-rectum, which is never very large even when infected with growth.

The size and length of the posterior surface of the prostate are noted and the nature of the surface, whether it is smooth and rounded, or lobulated or irregularly nodular; the consistency, whether it be soft and elastic, tough and fibrous, or of stony hardness. Owing to the arrangement of the vesiculæ the upper border of the mass formed by the prostate and vesiculæ feels heart-shaped, and appears to present a median groove running on to the posterior surface of the prostate. The condition of this notch must be investigated most carefully, as it is here that the first deposits of cancer are felt after the growth has broken through the prostatic capsule.

Adenomatous prostates do not necessarily feel *enlarged per rectum,* though they may be causing dangerous symptoms. The more a prostate projects into the rectum the less likely is it to be causing severe urethral obstruction, and *vice versâ.* The practitioner must not therefore be disappointed if the symptoms suggest prostatic disease and yet he can feel nothing by rectal examination. The prostates that cause the worst urethral obstruction are those which grow upwards into the bladder, especially the "median lobe" type.

In such cases the diagnosis has to be confirmed either by bimanual, rectal and abdominal examination, the bladder being empty, which gives an excellent idea of the size of the prostate if the belly-walls are relaxed, or by other methods. It is just in these cases that the cystoscope becomes essential for purposes of diagnosis.

The cystoscope.—After a short prophylactic course of urinary antiseptics the patient is confined to bed in a warm room. The urethra is washed out and anæsthetised with novocain, the cystoscope passed and the following conditions looked for; trabeculation and pouching of the bladder-wall—evidence of back-pressure and hypertrophy; the condition of the ureters and the urine that escapes from them; the presence or absence of stones, ulcers, and tumours; and finally the condition of the trigone and internal meatus. A dusky rounded tumour may at once be seen raising the floor of the trigone or the lateral walls of the bladder. In other cases an accurate diagnosis of the trouble can be made by withdrawing the prism till it is half within the urethra, and slowly rotating the cystoscope. The normal internal meatus is a smooth circle, but the meatus surrounded by prostatic adenomata is irregular and nodular. Before the cystoscope is removed valuable information can be gained by endeavouring to palpate the metal tube with a finger in the rectum.

The X rays may reveal unsuspected calculi, both vesical and renal.

The urine in the early stages is perfectly healthy, but sooner or later the back-pressure begins to tell on the kidneys and there is polyuria with the passage of a pale, low-density urine, deficient in the proper percentage of urinary salts and pigments. A trace of albumen may be detected but in many cases it is absent, nor are casts necessarily found. The daily amount must be collected and measured, and the various tests of renal function applied, there being no need to separate the urines from each kidney for this purpose, and it is well to remember that the kidneys may be extensively diseased though no albumen or casts are found in the urine.

When infection has occurred pus and bacteria appear in the urine, which may remain acid or become foul and ammoniacal.

Glycosuria is not uncommon, and is an important element in prognosis, as it invites bacterial infection of a severe grade; but it can usually be controlled by diet and the exhibition of codeina.

Diagnosis.

The diagnosis has to be made from other causes of urethral obstruction, and from other causes of enlargement or disease of the prostate.

(1) From other Causes of Urethral Obstruction.

(a) *Organic gonorrhœal stricture* is a disease of the third and fourth decades of life, but it is not unusual to encounter it in persons over fifty. The history is of little help, as there are few people that have not had gonorrhœa at some time or other, so that the condition is not discovered until attempts are made to pass an instrument. In cases of adenomatous prostate there are few urethras that will not take a No. 8 English scale with ease, whereas a stricture small enough to give trouble runs from No. 1 to No. 6 English. The obstruction caused by stricture is met with within six inches of the meatus, whereas that of a prostate is not less than seven inches away. Personally we hesitate to diagnose stricture without the aid of a urethroscope, though a bougie is fairly reliable if the urethra has been adequately cocainised before its use. Many a stricture is diagnosed with the bougie which is nothing more than a spasm of the compressor urethræ. It should never be forgotten that a man with a stricture may also be suffering from adenoma of the prostate, and that the diagnosis of stricture in a man over fifty is not always a sufficient diagnosis.

(b) *Nervous disorders* of the bladder seldom come on after the age of fifty, the age of onset being from twenty-five to forty-five, when such diseases as disseminated sclerosis, tabes dorsalis, the various forms of myelitis and general paralysis are met with. Such patients may also develop adenomatous prostates if they survive beyond the age of fifty, and cerebral hæmorrhage may occur in aged prostatics, and may be a cause of relaxed sphincters. The diagnosis is sometimes suggested by the relaxed rectal sphincter, which leads to a thorough investigation of the nervous system.

(2) From other Causes of Enlarged Prostate.

The age-limits of prostatic disease are of value in diagnosis.

From twenty to thirty-five there are three causes of enlarged prostate—prostatitis, tuberculosis, and sarcoma. These are so rarely encountered in men over fifty that they can be excluded.

From forty to fifty carcinoma of the prostate occasionally occurs, but adenoma is almost unknown. After fifty there are only two common causes of enlarged prostate—adenoma and carcinoma—and about one out of every ten cases met with will be carcinoma.

The frequent occurrence of malignant disease of the prostate has only become apparent in recent years, but it is a well-known fact to those whose business it is to examine with the microscope a large series of prostates removed at operation. Carcinoma may arise *de novo*, or in the midst of an adenomatous prostate. The diagnosis is not difficult in the majority of cases if the mind is aware of the fact and is on the alert for minute indications. Most, but not all cancers of the prostate are of a peculiar stony hardness, which can only be learnt by constant experience, and in the early stages such a small, hard area may be detected in the midst of an ordinary adenoma, or in an otherwise normal prostate.

The disease bursts through the capsule of the gland along the posterior superior border, and invades the sheaths of the vesiculæ and cellular tissue beneath the base of the bladder, so that instead of a notch being felt at this point, a hard, slightly nodular plaque is felt filling up the gap. Hard, irregular outlying nodules of growth are characteristic, but must not be confused with the hardness of smooth, rounded prostatic calculi and phleboliths. When the growth is far advanced it becomes fixed as in a vice to the floor and sides of the pelvis. The cystoscope is gripped as it passes through the prostatic urethra with a peculiar, hard, grating sensation, and when passed may reveal a nodular, flattened, irregular, median bar lying behind the internal meatus, or, rarely, an ulcer formed by the growth which has burst through into the bladder.

The hardness of the growth can be well appreciated if a finger be inserted into the rectum while the cystoscope remains in the bladder.

Extensive secondary deposits in the bones of the limbs and vertebræ are common, even when the primary growth in the prostate is small, and we have known bone pains and endosteal bone-tumours to be the first symptom of the disease. For instance, a man applied for relief complaining of difficulty in micturition and pain in the right arm. An examination of the arm revealed a small tumour in the shaft of the humerus, and rectal examination clinched the diagnosis when a small, stony prostate was discovered.

Treatment.

We shall discuss first the general palliative measures to be adopted, with due discrimination, in dealing with all cases, no matter in what stage they are or what other treatment they are undergoing, secondly the best way to proceed at the first visit and examination, thirdly the choice between catheter-life and operation.

1. General Palliative Measures.

If circumstances permit, the patient should dwell in a warm, dry climate, and his clothing should be warm enough to ward off the risk of sudden chill. Anything which is likely to cause congestion of the pelvic veins must be avoided, such as the indulgence in heavy meals, the heavy wines and beers, the best form of alcoholic drink being a light claret or hock, well diluted with mineral water. The most suitable diet is that recommended for gouty patients (see Ch. V, Sect. I). The best drinks are milk and the various mineral and diuretic waters. So long as there is no unrelieved obstruction to urination the kidneys will derive benefit from regular flushings, and the intake of water should be at least four to five pints a day.

If infection be feared or be threatening, a course of urinary antiseptics is indicated, the best being urotropin (gr. iij), ac. sod. phosphate (gr. xx), or sod. benzoate (gr. v), given three or four times a day in plenty of water. To ward off infection and incidentally diminish the risk of cerebral hæmorrhage, easy and regular daily actions of the bowels must be secured. Other remedies to help the cardio-vascular and lung conditions are the avoidance of any sudden exertion, such as running to catch a train; proper covering for the feet, and the use of massage to the limbs, and regular daily breathing exercises. The skin must be kept clean and active by a daily hot bath, and an occasional Turkish bath is of service if the heart be steady, but care must be taken to avoid chill afterwards.

2. Procedure at the First Examination.

1. *The "irritable" type*, who comes complaining of increased frequency and difficulty in starting the stream, where the bladder is not distended, and the prostate is soft and of moderate size, should *never be submitted to catheterisation at the first visit.*

He should be given a few weeks' course of drugs calculated to improve the tone of the bladder-muscle, such as extr. nuc. vom. gr. ¼, or tr. ergot. amm. 1 drachm *t.d.s.*, and be watched for some months. When this line of treatment fails to relieve the symptoms it is time to consider the question of catheter life or operation.

If it is decided to pass a catheter a three days' course of urotropin is given, the bowels are well cleared, and the condition of the heart and vessels is considered. The patient is confined to his bed and kept warm, the anterior urethra is washed out, the whole urethra anæsthetised, and a soft or flexible catheter is then passed with the full antiseptic details described on p. 278.

If there is less than four ounces of residual urine there is no need to institute catheter-life; if more than this catheter-life or operation are the only two alternatives.

2. *The "painful retention" type.*—The bladder is half way to the umbilicus, and passes into distressing cramps every few minutes, yet no water is passed, and the prostate is large, soft, and gorged with blood. The retention must be relieved, and that quickly.

Administer a large dose of opium—either thirty minims of the tincture by the mouth, or a suppository containing half a grain of morphia, and put the patient to lie in a hot bath. This treatment rarely fails to relieve the condition completely, but if it does fail resort must be had to the catheter with all the precautions previously mentioned.

The best type of catheter is the soft red rubber, but as it has to be freely fingered during its passage the fingers must be covered with sterile rubber gloves. The best sizes to start with are Nos. 8, 9, or 10 of the English scale. If these cannot be passed a No. 8 E gum-elastic catheter *condée* or *bi-condée* should be tried. The best type of gum-elastic catheter for these cases is "The Marshall," prepared by Bell and Croyden, with a hard-tipped olivary curved nose, and a flexible shaft, as it can be boiled and passes with great ease. The day of the long silver prostatic catheter is over save for exceptional cases in skilled hands.

The bladder should never be completely emptied, but only sixteen ounces should be drawn off at the first attempt, and the procedure is followed by the administration of urotropin, gr. x, in half an ounce of gin and four ounces of hot water. The process is repeated every four hours, sixteen ounces being withdrawn each time, until the bladder is emptied and

the patient begins to pass water again naturally. If the practitioner fails to pass the catheter, and especially if he has made a false passage which bleeds profusely, he had better desist, and either aspirate the bladder above the pubes with a fine pleural needle, or open the bladder supra-pubically and insert a short rubber drainage-tube. If nothing can be drawn off by the catheter, *the bladder is probably full of blood-clot,* and a little plug of blood-clot will be found in the eye of the catheter after withdrawal ("clot retention"). The best treatment in these circumstances is to obtain leave to open the bladder above the pubes, control the bleeding point, and drain the bladder for ten days. Failing this the only way is to crush the clots and evacuate them with a large evacuating tube and a Bigelow's evacuator.

At the close of the attack, which may not last more than a single day, urine is again passed naturally, and it may be many months before another attack comes on if the patient is careful to avoid pelvic congestion and chill. Nux vomica and ergot should be administered and the patient watched.

If, however, the retention remains complete, and no water can be passed at all without the catheter, the question of catheter-life or operation must be considered.

(3) *The "painless incontinence" type,* who is usually showing the danger signals—namely thirst, morning sickness, headache—and has a painless flaccid bladder which reaches the umbilicus, the prostate being small and firm, is to be treated with the utmost circumspection and judgment, as he is on the brink of disaster and can so easily be precipitated over the edge.

He should be put to bed and the dangers of his state and the risks of a catheter explained to his friends, and consent should be obtained for whatever procedure is adopted. If the bladder be emptied suddenly and completely by a catheter suppression of urine is the almost invariable sequel, the usual explanation given being that the kidneys are unable to withstand the sudden release of tension. The object is to empty the bladder slowly over a period of two or three days, which can be effected in two ways.

(1) A No. 4 English scale catheter is passed, tied in and allowed to remain till the bladder is empty.

(2) A No. 8 English scale catheter is passed every four hours and sixteen ounces of urine are withdrawn each time.

The general condition of the patient may improve so remarkably after a week in bed, on urotropin and plenty of

fluid, that an operation may sometimes be undertaken after that time with reasonable hope of success.

Supra-pubic puncture is not suited to this form of retention and better results follow from immediate supra-pubic cystotomy. For some reason or other the sudden release of tension by this route does not so often lead to suppression as it does when a catheter is used, which suggests that the suppression may after all be due to a deep urethro-renal reflex.

These three types have been discussed in detail, as the practitioner has been left in doubt in the past as to the best line of action, the result being often unfortunate from the use of the catheter without due precaution, and often when there was no real need for the catheter at all. *The catheter is not an instrument to be used routinely in diagnosis.* The only practical estimates of residual urine are into small, moderate, and large, as made by palpation. The catheter is an instrument *sometimes* required in treatment, and *then* only to be used with extreme precaution.

3. The Choice between Early Operation and Catheter-Life.

When a patient applies for relief in the early stages two courses lie open to the surgeon. He can prescribe bladder tonics, and watch the course the disease is going to take, having informed the patient of the nature of his malady, the kind of course it may run, and the possible lines of treatment; or he may urge an early operation. Against early operation are—first, the difficulty in persuading the patient that the disease is serious enough to warrant it; secondly, the fact that many prostatics go on for five, ten, fifteen years with very little trouble save for an occasional attack of retention, and until the case has been watched for a little it is impossible to say that it will not conform to this type; thirdly, the greater difficulty of the operation in the early stages when the adenomata are small and have not developed a definite capsule to render enucleation easy.

In favour of immediate operation are—first, that this benign course is not the common course, which is one of increasing difficulty in urination leading up to complete retention or overflow, with attacks of cystitis, stone, hæmaturia, pyelitis. Secondly, that if the obstruction remains unrelieved the kidneys are slowly being destroyed by back-pressure, diminishing the chances of successful operation or catheter-

isation at a later date, and affording a ready prey for bacterial attacks; the bladder is altered, its capacity diminished, its walls pouched, its tone lost, and it is ripe for attacks of cystitis and stone. Thirdly, that the earlier operation is performed the more fitted is the patient to stand its risks—shock, uræmia, infection, and lung troubles—owing to his age, and his intact kidneys and cardio-vascular system.

If there seems little need for active interference and the prostate is small, we advise waiting for six months to a year while the patient is kept under close observation, especial attention being paid to any troublesome symptom, the power of the bladder to empty itself being watched, and the general effect on the kidneys and vascular system being determined by observation of the urine and the blood-pressure and heart. If, on the other hand, the prostate is large and soft, so that the surgeon can feel confident of ease in enucleation, and if the patient is in a poor walk of life, and is dependent on his daily work for his living, we are strongly in favour of urging an immediate operation, for which complete success can be promised. Sooner or later a prostatic will be driven to undergo more active treatment, being worn out by pain, disturbed sleep, and soiled garments, or by attacks of retention, incontinence, hæmaturia, cystitis, and stone. His choice must eventually lie between catheter-life and operation, nothing else being left to him. Too often he is persuaded to start on catheter-life, the choice not having been put to him by his adviser, who is ready to pass a catheter but is averse from advising the operation.

The mortality of catheterisation is higher than that of operation. This statement needs to be driven home in the minds of the profession and the public. At present it is imagined that it is a trivial thing to pass a catheter, but the sound of the word "operation" suggests endless risks. We are convinced that it is a more dangerous thing to pass a catheter, in the way a catheter is usually passed, on a patient over fifty, than to submit him to an operation. Of course if the patient be in good condition, and adequate precautions be taken such as we have detailed above, the risks of the first catheter are reduced to a minimum, but they are still very considerable from shock, suppression, uræmia, and sepsis. The danger increases when the process is repeated day after day by the patient himself, when familiarity begins to breed contempt. We admit that there are some favoured gouty individuals who can carry an unclean catheter about with

them for daily use without becoming infected, but they are too exceptional to be used as an argument.

Watson collected 207 cases of first catheterisation in which the histories were followed up, and found that 8 per cent. had died within the month, which compares most unfavourably with the 4 to 6 per cent. mortality of prostatectomy. Were the deaths within the first year taken they would prove to be far more numerous after catheterisation than after operation.

A catheter never cures—it only puts off the evil day; its use will have to be continued throughout the rest of life once, twice, or many times a day; and most people can neither afford the time and expense necessary to devote to the proper practice of the act, nor will their occupation permit them to carry it out during the day-time.

We advise the catheter in cases of carcinoma if absolutely necessary; in patients who do not come up for treatment till they are moribund, and on whom a catheter must be passed to render the end less painful from distension and cystitis; and, finally, in well-to-do patients who can afford the time to practise catheterisation properly, and who do not as yet desire an operation. Well-to-do patients may live a catheter-life for twenty or thirty years, but it seems a lot of trouble to take when one thinks of the contrast in those who have undergone a successful prostatectomy: no need for a catheter, restful nights, no retained urine.

If stone is present, if bleeding be severe, and, above all, if retention be complete, the need for operation becomes almost imperative.

In favour of operation can be urged that the immediate mortality is certainly no greater than that of catheterisation, whereas the remote mortality is undoubtedly far less, and diminishes almost to a vanishing point if the operation be performed early in the course of the malady. That it is fair to speak of an absolute cure if operation has been performed on an uncomplicated case—that is to say, there is no more obstruction to the stream, no more catheters are required, the dangers of uræmia, infection, and stone have been removed, and sexual power is not destroyed. The lost tone of the bladder-muscle is quickly recovered, even though it was completely lost, and in most cases the patient can go on for years without requiring any further treatment. There can be no doubt whatever that a successful operation adds many years to a patient's life. If the passage of a catheter is difficult, or

is rendered hopeless by the patient's income or occupation, an operation offers a ready escape from these difficulties.

Against operation can be set the risks of death from shock, uræmia, sepsis, and lung troubles, but these are no greater than after catheterisation; and the fact that a few cases are not completely successful—being troubled with persistent fistula (2 per cent.), incontinence (2 per cent.), and stone. Incontinence is not found after the supra-pubic operation, and a fistula can be remedied by a second operation. As for stone, those who develop a stone would have done so on catheter-life, so that this cannot be used as an argument against the operation.

Summing up, we may say that the operation is certainly the most successful of modern surgery when we take into account the age and general condition of the patients, the troubles and dangers they are rescued from, and the comfort of the after-state.

Catheter-life.

The first catheter is passed with all the precautions noted above, the patient being in his own bed, and remaining there for twenty-four hours afterwards. After that there is no need for bed, though if the catheter is passed only once a day the night is the best time, so that bed can follow, and the night's rest may be undisturbed by calls to micturate.

The catheter is to be passed with full antiseptic rite, and many ingenious devices are on the market to help in the sterilisation and carrying about of catheter and lubricant, which can be obtained from the instrument makers.

The safest methods are those where a catheter and lubricant are placed inside a metal case, and the whole is sterilised by heat (see also Ch. IV, Sect. V).

If the residual urine is more than four ounces a catheter should be passed once a day, at bed-time; if it is over eight ounces a catheter should be passed night and morning.

Many patients can pass no water at all, so that a catheter must be passed whenever they feel a desire to micturate, and, as this may be every hour, the difficulties and worries of catheter-life are not small.

Operation.

For the common form of enlarged, elastic, adenomatous prostate, two forms of prostatectomy are open at the present day—the supra-pubic and the perinæal.

It is true that for the uncommon, tough, fibrous variety enucleation is out of the question, and resort must be had to other forms of operation, such as prostatotomy, *morcellement*, or the Bottini operation, but at present these can be left out of account.

The rationale of the modern operation depends on the fact that an adenomatous prostate, unlike a healthy prostate, can be enucleated from a definite capsule, the urethra and ejaculatory ducts being sometimes torn across in the process, but without any detriment to a perfect after-result. Opinions are still divided as to whether the whole prostate is removed or only the adenomatous portion, the remainder of the gland being pressed out to form a capsule for the adenoma. There is no space to go into the arguments on the different sides, but the fact remains that the larger the tumour the more easy the enucleation, and that it does not much matter if the urethra and ejaculatory ducts be torn. This fact that enucleation could be performed was known to surgeons in the nineties of last century, but it was laid aside during the extensive trial of vasectomy at the end of the century. The disappointing results of that operation brought the enucleation operation back into the important place it now occupies in surgery.

The Causes of Death after the Operation.

1. *Uræmia* accounts for the larger number; but this can be avoided by earlier operation, and, if it is already threatening, by the help of preliminary drainage combined with copious drinking of water, coupled with saline infusions if vomiting be severe, and rest in bed for a few days.

2. *Shock* is responsible for fewer deaths than ever now that the condition is better understood, and if efforts are made to prevent a fall in blood-pressure by means of nerve-blocking to protect the vaso-motor centres from bombardment with painful afferent nervous impulses.

Spinal anæsthesia is the ideal method of nerve-blocking; but it can also be attained by anæsthetising the deep urethra and bladder with 20 minims of 5 per cent. novocain injected into the empty bladder with a Guyon's syringe at the start of the operation.

Ether is gaining ground as the more suitable general anæsthetic, as it has a well-marked diuretic effect on the kidneys, and appears to be no more harmful to the parenchyma cells of the kidney than chloroform, and, in

addition, it helps to maintain the blood-pressure, but it may be contra-indicated by the state of the lungs.

After the operation such measures as bandaging the limbs and abdomen, lowering the head, saline infusions, and the exhibition of ergot will be found of service in this connection.

3. *Sepsis* is guarded against by flushing the kidneys and bladder from the blood by means of copious drinking of diuretic waters, by urinary antiseptics (urotropin gr. v, acid. sod. phosph. gr. xx), by securing free drainage for the bladder, by damaging the floor of the bladder as little as possible, and by continuous or intermittent lavage of the bladder and urethra.

The bladder can be washed out with an irrigator by way of the drainage-tubes by means of a catheter *à demeure*, or passed at regular intervals, or better still, by employing the method of Janet. A short drainage-tube is inserted into the supra-pubic opening and left in place for forty-eight hours until granulation tissue has had time to form and shut off the urine from infiltrating the cellular tissue of the cave of Retzius.

4. *Hæmorrhage* is seldom severe, but it may be so profuse as to become alarming, though hardly ever fatal. Treatment should be prompt, and consists in washing out the bladder with salt solution at 115° F., to each pint of which has been added a drachm of adrenalin solution (1 in 1000). If this treatment fails, the wound should be opened up under an anæsthetic and explored with a "caisson" and the head-lamp, when a definite bleeding point can usually be found and controlled by forceps or ligature. If all other measures fail, gauze-packing can always be relied upon, the gauze being applied direct, or by means of a catheter and tampon passed into the bladder and out through the urethra.

5. *Pulmonary embolism* remains to be considered, and is a complication that appears with remarkable persistence in the published statistics of most surgeons, nor is it to be wondered at when we consider the damage that may be done to the dense plexus of veins round the neck of the bladder, and that the opened veins may be bathed in a septic fluid for some days. Extensive thrombosis of the pelvic veins must be common after the operation, and many of the lung complications, broncho-pneumonias and pleurisies, so often noted after this operation and that clear up completely, seem to be due to mild degrees of septic pulmonary embolism.

If the view be adopted that embolism is due to the throm-

bosis of the pelvic veins from damage and sepsis, the patient must be kept quietly in bed for at least three weeks after the operation, as sudden death might be expected to occur at any time within that period from this complication; but it is only fair to state that some surgeons consider that thrombosis is not so much due to sepsis as to the stagnation of blood from the enforced rest in bed, aided by the increased tendency to clot formation induced by the high calcium content of a milk diet. They therefore allow their patients up in a chair in two or three days, and many get them out in the open air and walking within the week, and see to it that the patient's legs are massaged, that he is shifted frequently from side to side, and is encouraged to perform breathing exercises. The milk diet is corrected by the use of sodium citrate in the milk (gr. xx, ad 1 pint). The question can only be settled by the results of such treatment carefully reported.

Late Complications.

In the majority of cases the wound heals soundly in three to four weeks and the urine becomes clear, and the general health improves remarkably with the freedom from sleeplessness, constant attention to micturition, pain, and so forth. The tone of the bladder is gradually regained.

A *supra-pubic fistula* may be left for a time, but can be made to close if a full-size steel sound be passed through the urethra every week for a month or so, and by the application of silver-stick to the sinus.

Recto-vesical fistula was a common complication at one time after the perinæal operation, and was one of the causes that caused it to fall into disrepute in England; but it can be certainly avoided if the levator ani muscles are stitched together after the operation to prevent the rectum slipping forwards into the perinæal wound and becoming nipped or infected.

Incontinence caused by injuries to the compressor urethræ is also an occasional complication of the perinæal route.

Stricture of the torn urethra is very rare, but it does occur, as we have seen a specimen at the autopsy in a man who died three months after operation, and have also seen one or two instances during life in cases already operated upon. It can easily be remedied by the regular passage of steel bougies.

Cystitis is readily controlled and cured by antiseptics and

lavage, but if a patient has contracted a mild pyelo-nephritis it is extremely difficult to rid him of his pyuria and bacteriuria (see Ch. VII, Sect. I). Though little effect is produced on the general health the condition is constantly liable to exacerbations and to the production of calculi. Such patients can be kept comfortable if they will report themselves twice a year for cystoscopy followed by a thorough bladder-wash with the aid of the evacuator.

The merits of the respective routes cannot be discussed in great detail, but a very good case can be made out by the advocates of either method, and both are about equally safe in the hands of an expert who has assiduously practised them.

The supra-pubic method will continue to hold the field in England, where specialism is still in its infancy, for the following reasons: It is an easier operation and requires less practice and less accurate knowledge of minute anatomy of the parts, so that in general the risks of bad after-results such as fistula and incontinence are far less.

The mortality of the perinæal operation would certainly be raised if it were more extensively practised, so that comparisons of mortality statistics are valueless at present. The prostatic urethra is often torn in the perinæal method, as many of those who practise it confess, nor does such an event necessarily add to the risk of the operation. The conservation of the ejaculatory ducts is a matter of little moment so far as coitus is concerned, and the question of sterility is seldom one that needs consideration at such a time of life. The likelihood of missing and the difficulty in dealing with stones by the perinæal route is a serious drawback to the operation even in expert hands. The after-treatment is far more easy to control by the supra-pubic method, and the patients can be kept dry in bed from the very first—a point by no means to be despised.

For the tough, fibrous prostates that cannot be enucleated, attempts may be made to remove the gland piecemeal, or the gland may be seared with the cautery after the method of Bottini. If the condition be correctly diagnosed before the bladder is opened, satisfactory results can be obtained by opening the membranous urethra, inserting a finger, and stretching the prostatic urethra thoroughly (prostatotomy), a manœuvre which will often give relief for some years, and the patient with the tough prostate has seldom many years to live as his kidneys are generally small and fibrotic.

CHAPTER II.

CARCINOMA OF THE PROSTATE.

It is becoming increasingly evident that carcinoma of the prostate is a common disease. Albarran and Hallé state that 14 out of 100 prostates removed at operation showed microscopic evidence of carcinoma. Young denies that it is common for an adenoma of the prostate to undergo malignant change, but states that 21 per cent. of all his cases of "enlarged prostate" were malignant. Carcinoma usually arises *de novo* in the normal prostate, but there can be no doubt that a benign adenoma may exist as such for years, and at any time may undergo malignant change.

Nothing is known as to any exciting or predisposing cause, but the disease is rare before the age of fifty-five years. The optimum age is from sixty to seventy, but, unlike adenoma, carcinoma does sometimes occur in patients aged forty to fifty years. Under forty years malignant disease of the prostate is extremely rare, and when it does occur it is sarcoma rather than carcinoma.

Morbid Anatomy.

The disease is discovered in three different forms:

(1) In the midst of an adenoma which has been shelled out at operation a small area is detected of almost stony hardness. A section made through this area reveals a tiny patch of scirrhous carcinoma in the midst of the adenoma, the stroma, increased in amount and in hardness, passing outwards in rays to fuse with the general stroma of the adenoma, and surrounding yellowish, softer areas of epithelial cells, contrasting strongly with the elastic, sponge-like structure of the adenoma.

(2) The carcinoma is still confined within the prostatic capsule, but involves the whole gland. The gland is somewhat enlarged and of stony hardness. On section the stroma is increased in amount, is dense, hard, and translucent, and surrounds yellowish areas which consist of epithelial cells.

Patches of cystic and hæmorrhagic degeneration may be seen.

(3) The carcinoma has burst through the prostatic capsule and extends into the pelvic cellular tissue, backwards and upwards along the vasa and vesiculæ, outwards to the lateral walls of the pelvis, and forwards along the pubo-prostatic ligaments to the *cavum Retzii.*

Histology.

In the harder forms the connective tissue of the stroma is much increased in amount, and epithelial cells can be seen lying in the connective-tissue spaces in irregular groups. The alveolar spaces are either filled completely with cells, or are lined with several layers of cells, and show a single lumen, or present multiple lumina, each surrounded by a circlet of cubical cells arranged in a single row (adeno-carcinoma).

In the softer forms the whole gland is converted into a dense mass of epithelial cells, cut up into loculi by delicate strands of connective tissue.

Modes of spread.—There are two main varieties; in one a small nodule of growth is found in the prostate, still confined within the capsule, but there are extensive secondary deposits in the bones and lungs or in the lumbar lymphatic glands; in the other there is extensive local spread to the surrounding tissues but little general metastasis.

In the chronic forms the disease may lie dormant for a long time without producing either local or general metastasis.

Local spread along the connective-tissue spaces.—The cancer-cells make their way through the connective-tissue spaces of the stroma and capsule, but find their further course backwards barred by the anterior layer of the recto-vesical fascia or fascia of Denonvilliers. *They then pass upwards and backwards* along the walls of the vasa deferentia and vesiculæ towards the ureter and the base of the bladder, and outwards along the lateral ligaments of the bladder to reach the wall of the pelvis and nerves of the sacral and lumbar plexus, and the lymphatic glands of the iliac, hypogastric and lumbar groups, which in 20 per cent. are invaded before the end. Less commonly they spread forwards along the pubo-prostatic ligament to reach the cave of Retzius, and they may invade the wall of the membranous urethra and spread out into the bulb and corpora cavernosa of the penis.

In comparatively few cases a deposit forms beneath the trigone of the bladder and ulcerates through into the floor of the bladder, but the urethra itself remains intact throughout, and the rectum is hardly ever invaded to the point of ulceration.

The growth rarely invades the ureters, but it may surround and press upon their lumen, setting up hydronephrosis or pyonephrosis.

Metastatic deposits are common in the marrow of the vertebræ, long bones, ribs, and skull-bones, and are seen as multiple nodules of growth which are seldom large enough to expand the surface of the bone to any marked extent. We have seen nearly every bone in the body invaded by nodules of growth when the primary focus in the prostate yet remained quite small and confined to a portion of the gland. Similar deposits are seen in the lungs, and occasionally in other viscera.

Symptoms, Signs, Course.

The disease has a long latent period, so that cases seldom present themselves for diagnosis and treatment until it is too late for any radical measures.

The patient may have suffered for years from "prostatism," when the disease is grafted upon an adenoma, but more often the complaint arises *de novo*, the symptoms resembling those of benign enlargement, though they are more severe and run a more rapid course.

The onset varies greatly, the commonest being increased frequency of micturition combined with difficulty and burning during micturition; but sometimes it is an attack of acute retention which remains complete, or it may be a sciatica or a lumbago, or bone-pains and spontaneous fracture, or an attack of hæmaturia, or œdema of one or both legs.

As the disease is established the patient may complain of any or all of the following symptoms:

The frequency of micturition is increased, especially by night.

Micturition becomes increasingly difficult, the stream coming away in drops or driblets. If retention once becomes complete the stream is very rarely re-established, nor is it common to find overflow, so that regular catheter life or drainage becomes a necessity.

Pain is by no means an invariable feature, nor when present is it at all characteristic. The same widespread pains can be

felt as in chronic prostatitis (see Ch. IV, Sect. IV), and it is sometimes hard to say whether these are true referred pains set up by local disease of the prostate, or reflected pains set up by involvement of the sacral and lumbar nerve-trunks in secondary deposits. The point is a practical one when treatment has to be considered, and it is not possible to say that sacral or lumbar pain is a certain contra-indication to operation unless secondary deposits can be felt in the hypogastric or lumbar glands or the pelvic cellular tissues.

Pain may be a slight dull ache or be severe and lancinating, and be felt in the neck of the bladder, along the root and into the head of the penis, in the rectum and sacrum, down the backs and inner sides of the thighs, in the testicles and groins, or in the front and back of the loin.

Hæmaturia is not a common symptom, in which the disease differs markedly from bladder tumours, this being due to the fact that the growth hardly ever ulcerates into the deep urethra and very seldom ulcerates through the trigone of the bladder. When it does occur it is nearly always associated with an ulcer on the floor of the trigone.

Bone-pains.—Aching pains, worse at night, may be felt at the site of secondary deposits in the bones, and slight expansion of the shafts of the bones may be felt in these situations which are tender and may present egg-shell crackling or even spontaneous fracture.

Signs.

Rectal examination.—The characteristic features of a carcinomatous nodule in the prostate are its stone-like hardness and its indefinite outline, and in the later stages the obliteration of the intervesicular groove and fixity to the side of the walls of the pelvis. Sometimes the prostate is hardly at all enlarged, but a stony nodule can be felt in one lobe or the whole gland is indurated and fixed. At other times the gland is grossly enlarged; it may be as an elastic adenoma in which there lurks a stony area of carcinoma, or as a large complete mass of hard carcinoma, the outline of which may be rounded and lobed, or be irregular and nodular, but the consistence of which is inelastic, board-like, or stony.

When the growth has invaded the peri-vesical tissues a dense board-like plaque of growth can be felt between and behind the vesiculæ, which obliterates the groove between the vesiculæ and is in marked contrast to the smooth convex

surface of the normal prostate and the heart-shaped border and groove formed by the upper border of the vesiculæ and prostate. Shot-like nodules and cords may be felt running up behind the vesiculæ, or outwards to the lateral walls of the pelvis, and the enlarged gland may appear to be fixed all around to the pelvic walls, as though set in plaster.

If a catheter or cystoscope be passed it is gripped in the deep urethra, and passes with a peculiar dry-grating sensation, and may cause a little bleeding. No rounded intravesical projections are to be seen, but the internal meatus may present a few small irregular projections, and the base of the bladder be raised by the growth, and rarely an ulcer is seen on the trigone when the growth has made its way into the bladder cavity.

The urine shows no characteristic change, but in the later stages it becomes purulent from secondary infection.

Masses of enlarged lymphatic glands may be felt in certain cases, and the glandular tumour may be far more striking than the primary focus in the prostate. Such a tumour may be met with along the iliac arteries, along the sides of the vertebral column, and even in the mediastinum and left side of the neck.

The bones should be palpated for rounded expansions in the course of their shafts, which may be painful or painless, and may become the site of spontaneous fracture.

Course; Duration.

The disease may run a rapid course of six to twelve months' duration, but in other cases the course is very chronic and may be dragged out for three or four years or even more. There is increasing difficulty and pain during micturition, retention becomes complete, and catheterisation more difficult and distressing if not quite impossible. The patient wastes, and is carried off either by a combination of back-pressure and infection of the kidneys or from the effect of general metastases.

Diagnosis.

The diagnosis is seldom difficult in cases too advanced for operation, but is extremely hard in early cases unless it be remembered how common the disease is, and that it must always be excluded before the surgeon rests content with a diagnosis of adenoma of the prostate. It is surprising how often a prostate is shelled out at operation and is found to

contain a malignant nodule buried in it. Only by better and earlier diagnosis can the results of radical operative treatment be improved.

In the early stages the disease has to be distinguished from other diseases of the prostate such as adenoma, the fibrous prostate of chronic prostatitis, tuberculosis, prostatic calculi, phleboliths, and from diseases of other organs such as carcinoma of the bladder, pericystitis, and vesical calculus.

1. *An adenoma* is soft, elastic, well-defined, and freely movable in the pelvic floor, and well-marked grooves can be felt separating the bulging adenoma from the vesiculæ, bladder-base, and lateral walls of the pelvis. The cystoscope does not grate as it slides through the deep urethra, and reveals rounded lobulated projections into the bladder of the lateral and median lobes. With a finger in the rectum no area of stony hardness can be detected anywhere between the finger and the cystoscope as it lies in position.

2. *The small fibrous prostate* of chronic prostatitis (see Ch. IV, Sect. IV) can only be distinguished by delicacy of touch. The prostate forms a *tough*, inelastic collar round the urethra, or presents areas of *tough* induration, but nowhere is there any area that can be called stony, and there is a well-marked intervesicular groove, and the posterior surface of the prostate is concave backwards.

3. *The tuberculous prostate* is rare after forty years of age; it is seldom a large prostate, and it presents *well-defined* nodules that feel like peas set in the substance of the gland, and do not give the idea of fusing with the general stroma of the gland. Nodules in the epididymis, signs of vesical or renal tuberculosis, and the early pyuria and characteristic bacilli should render the diagnosis clear in every case.

4. *Prostatic calculi and phleboliths* are stone-like, but they are smooth, rounded, and well-defined, and when multiple may give a sensation of grating or crepitus. At the same time a large single stone sometimes resembles a nodule of carcinoma very closely, and only a radiogram or an exploratory incision can decide the question aright.

5. *Sarcoma* is a disease of young adults, and is so rare that it need hardly be considered.

6. *The infiltrating form of carcinoma of the bladder* can be distinguished by noting that the indurated plaque felt by rectal examination is set in the bladder-wall and lies above the normal prostate, which can be felt below it. The prostate is felt directly the finger rides on the internal sphincter,

whereas the bladder-wall cannot be felt for an inch or more higher up.

7. *Vesical calculus* might simulate the disease, but is at once distinguished by cystoscopy and radiography.

8. *Pericystitis and perivesiculitis* arising in the course of a urethritis or secondary to vesical calculus simulate very closely the feel of the diffuse form of carcinomatous prostate, save that the induration is hot and œdematous, and is not so stone-like as carcinoma. The age of the patient and the history are usually sufficient to exclude carcinoma.

Treatment.

Treatment is palliative and radical.

1. Palliative.

In some cases there is no call for any interference, but sooner or later the need for regular catheterisation will arise. Catheterisation should be deferred as long as possible, as infection is almost certain to follow and quickly put an end to life. The indications are—complete retention of urine, severe hæmorrhage, and cystitis for purposes of lavage, though it is questionable whether these are not better met by supra-pubic drainage of the bladder. A soft rubber catheter or an olivary gum-elastic are the best varieties to use, and the largest size that will pass should be employed, the strictest asepsis being maintained (see p. 278). If catheter-life is rendered impossible by pain, hæmorrhage, and difficulty of passage, relief can be obtained by establishing a permanent supra-pubic fistula. The opening should be high up on the anterior wall of the bladder, should be valvular, and a permanent dressing should be fitted by a competent instrument-maker in the form of a metal plate let into a belt and padded with indiarubber, pierced by a tube which can either have a tap attached to it or be led into a rubber bag which hangs down one trouser-leg. Double nephrostomy has been recommended and may sometimes prove a means of relief. Some authors report good results from the Bottini operation, and it may be considered worth a trial, as if successful a free passage for the urine will be re-established; but it is by no means free from the immediate dangers of shock and sepsis.

2. Radical Operations.

Enucleations of enlarged prostates containing a malignant focus have been performed in a number of instances owing to

a mistaken diagnosis, and many of these cases have healed up and recovered good bladder-function, and lived for a long time after the operation.

If a certain diagnosis of carcinoma can be made in the early stages, before the growth has obviously burst through the capsule and invaded the surrounding parts, and in the absence of any sign of bone-pain, sciatic and lumbar nerve-pain, glandular tumour, or other metastasis, then it is the duty of the surgeon to consider an attempt at radical excision of the disease based on modern lines. Mere supra-pubic enucleation is not enough, as small extensions of the growth along the vesiculæ and vasa may be left behind.

The operation devised and described by Young in the 'Johns Hopkins' Reports,' vol. xiv, 1906, appears to be the most radical and logical procedure yet evolved. The prostate is approached by the perinæal route, and the membranous and prostatic urethra, the prostate, a portion of the bladder, the vesiculæ, and parts of the vasa are removed in one piece by dissection, the cut urethra being afterwards re-united to the bladder. The compressor urethræ is sufficient to prevent incontinence after the operation when the wound is healed. The chief difficulty is to secure the suitable case in an early enough stage. The patient must be in good general condition and possess sufficient stamina for a long operation. The disease must be of the chronic type and be diagnosed early; the cancerous nodules must be felt to be still confined within the prostatic capsule except behind, where a small invasion of the vasa or vesiculæ is no contra-indication.

Absolute contra-indications are signs of invasion of the lateral or anterior ligaments of the bladder, with fixity of the growth to the sides of the pelvis; signs of stony masses of enlarged glands along the iliac arteries or sides of the vertebræ; evidence of secondary deposits in the bones, lungs, or other viscera; evidence of involvement of the lumbo-sacral nerves; œdema of the legs; hæmaturia or cystoscopic evidence of ulceration into the bladder.

Hopeful results may be expected in the future in a few carefully selected cases, if the practitioner is on his guard to detect the disease by early and discriminating rectal examination in all men over forty who suffer with signs of "prostatism."

CHAPTER III.

ACUTE INFLAMMATION OF THE PROSTATE.

Acute prostatitis is a disease of adult life (twenty to forty-five) when venereal disease is acquired, the vast majority of the cases being directly caused by gonorrhœa, but it can also occur quite independently of gonorrhœa as a primary blood infection.

1. Exciting Cause.

Bacterial infection	Gonococcus. Streptococcus. Staphylococcus. B. coli. Proteus, etc.

Mode of Bacterial Access.

A. *Local urethral infection.*—By the gonococcus and contaminating organisms. By a septic catheter or sound.

B. *In the urine*—from a blood infection of the kidney.

C. *From the blood direct.*—1. Organisms in the blood (see Ch. VII, Sect. I). 2. Acute specific fevers, pyæmias.

2. Predisposing Causes.

A. *Constant small traumas.*—Horse-riding, bicycling, prolonged marching.

B. *Habitual congestion.*—Sexual excess, constipation, sedentary life, alcohol.

The common cause is the gonococcus, which reaches the deep urethra and makes its way into the ducts and acini of the prostate, and it is estimated that when posterior urethritis is established the prostate is likewise infected in at least 90 per cent. of the cases. The gonococcus seldom reaches the prostate till within four to five weeks of the start of the urethral discharge, but in exceptional cases it may penetrate within two or three days. In such cases its career has usually been hastened by the use of too strong injections, or the passage of instruments; and horse-riding or bicycling are morally certain to lead to a severe prostatitis in a victim of recent gonorrhœa.

In the early stages the gonococcus itself can be found in the prostatic pus, but eventually it dies out, and after a year or eighteen months it is very rarely found according to the few trustworthy figures on record.

Primary blood infections of the prostate do occur, but they are not at all common, the bacteria being thrown out into the prostatic tissues from the blood direct, the predisposing causes being slight trauma, excessive horse-riding, or sexual excess.

A well-marked acute prostatitis may be seen for a few days at the beginning of an attack of acute cysto-pyelitis caused by the colon bacillus, etc. (see Ch. VII, Sect. I). The bacteria found are the same as those found attacking the kidney.

Pathological Anatomy.

In the milder forms the interstitial tissue is found to be engorged and œdematous, the acini being distended with pus, so that an appearance of miliary abscesses is produced—"follicular prostatitis." In the more severe forms the follicles of pus may coalesce to form larger abscesses, and the interstitial tissues are invaded by pus, which may even spread beyond the capsule of the gland, making its way into the urethra, rectum, pelvic cellular tissues, so that it is possible to describe a follicular, an interstitial, and a peri-cellular prostatitis.

Resolution generally occurs, and the exudation is absorbed or discharged through the ducts; or fresh interstitial tissue may be laid down producing a fibrous condition of the gland.

Abscesses, single or multiple, small or large, are not uncommon, and usually burst spontaneously into the urethra (63 per cent.), into the rectum (30 per cent.), into the peri-cellular tissue (15 per cent.), and into the bladder; sinuses and fistulæ are formed which seldom fail to heal spontaneously. A troublesome but rare complication is recto-urethral fistula.

If the inflammation spreads beyond the limits of the gland it may set up a localised abscess or a spreading cellulitis in the pelvic cellular tissues; it may infect the lymphatics and give rise to inflammation and abscess of the exterior iliac and hypogastric glands; or it may involve the veins of the prostatic plexus and set up thrombosis and pyæmia.

Symptoms and Signs.

In many cases of posterior urethritis the onset of prostatitis is insidious, and little or no enlargement can be felt by rectal

palpation, and it is only when the secretion of the prostate is examined later in the chronic stage that evidence is found that the prostate has been infected all the time. The yellow discharge from the anterior urethra dies down and may completely disappear when there are posterior urethral complications. In well-marked cases the onset is acute and marked by a slight rigor. The temperature is raised to 101° or 102° F. and the patient feels shivery, headachy and out of sorts. He complains of an intense burning pain during micturition, and apart from micturition may experience a dull throbbing pain deep in the perinæum, down the inner side of the thighs, and in the middle of the sacrum. He feels a desire to pass water every hour, and the stream comes out in droplets or is passed in short shoots with an interval between each. A few drops of blood may be squeezed out at the end of the act and partial retention with residual urine and complete retention are not infrequent. The rectum feels full, and there may be a teasing tenesmus, and the act of defæcation itself may be painful.

The slightest disturbance of the urethra, such as the routine washing-out of the anterior urethra for purposes of diagnosis, causes intense pain, and the patient shows a tendency to faint away. Under such circumstances it is advisable to administer a dose of ammonia and ether and defer further examination till the patient is safely in bed. Rectal examination reveals a distended prostate, the surface of which is smooth, evenly rounded, œdematous, and exquisitely tender to the touch. A careful look-out is kept for areas of softening which indicate an abscess, or for evidence of spread to the surrounding tissues, in which case the prostate is lost in a diffuse, hot, tender infiltration of the pelvic cellular tissues.

The acute stage generally passes away in from one to two weeks, the disease resolving and clearing up altogether or passing into a condition of chronic prostatitis.

Abscess formation is not uncommon, but as the abscesses usually burst into the urethra it is not always easy to prove that they have existed.

An abscess may be suspected when the temperature is persistently raised each evening to 101°–102° F. with the appearance of rigors and drenching sweats, and the patient wastes slightly and loses his colour. Micturition and defæcation become intensely painful, and a throbbing is felt by the patient deep in the perinæum. Rectal examination reveals a

tense and tender prostate, and if areas of softening can be felt the diagnosis cannot be in doubt. Otherwise there is often a prolonged period of uncertainty as to whether an abscess is present or not, the question being finally settled by the course of the disease, resolution rapidly taking place, or evidence of urethral or rectal rupture being forthcoming. From a practical point of view there is no need to interfere with a prostate suspected of abscess unless an area of softening on the posterior wall can be felt, when it is essential to open up the prostate at once from the perinæum so as to save infection of the rectum. In doubtful cases help may sometimes be obtained from regular leucocyte counts.

Spontaneous rupture occurs during defæcation, micturition, or a nocturnal seminal emission, or may be induced by the passage of a catheter.

Serious complications are uncommon, but include fistulæ, epididymitis, pyelo-nephritis, cellulitis, adenitis, phlebitis, pulmonary embolism, pyæmia.

Diagnosis.

The diagnosis is made by washing out the anterior urethra with boracic lotion after the method of Janet, and asking the patient to pass water into three glasses. If the first glass is hazy with pus, or contains purulent shreds and threads, it is an indication that the posterior urethra is infected. If rectal examination shows an enlarged and tender prostate there is no doubt of the diagnosis. Prostatic massage to obtain the prostatic secretion for microscopic examination should never be carried out in the acute stage of a posterior urethritis, as it increases the inflammation and may set up epididymitis. The diagnosis of abscess has already been considered. In the absence of gonorrhœa it is important to discover the bacteria at work, and any predisposing cause such as excessive riding.

There are only two other causes of enlarged prostate at the ages of twenty to forty-five—tuberculosis and sarcoma.

1. *Tuberculosis* produces hard localised nodules in the prostate which may or may not be tender, and there are always either nodules of tubercle in the epididymis, or other evidence in the kidney and bladder. The tubercle bacillus can be found in the purulent urine.

2. *Sarcoma* is extremely rare, but turns up with fair regularity in a large clinical field. There is a complete

absence of venereal history, no threads of pus in the urine, the swelling is very large, firm, elastic, fluctuating, but *not* tender and not hot or œdematous.

Treatment.

Local treatment is seldom called for in this disease, except when it is forced upon the surgeon by complications such as complete retention or unopened abscess.

The patient should be confined to bed and kept warm, the congestion and pain relieved by raising the foot end of the bed, and the application of hot fomentations and hot-water bottles to the perinæum. Hot baths bring great relief, as does the application of half-a-dozen leeches to the perinæum. The diet must be supporting but non-irritating to the urethra, spiced and smoked meats, condiments, curry, and uncooked vegetables being particularly harmful. Alcohol must be absolutely forbidden in any shape or form, and free diuresis should be encouraged by prescribing large drinks of mineral waters at regular intervals with the object of flushing the urethra from above. Small doses of sandal oil and urotropin are beneficial as they moderate the symptoms. The local pain and tenesmus can be relieved by suppositories of belladonna and morphia, and by continuous rectal lavage, and the bowels must be kept freely open. Posterior urethral irrigation and instillations cannot be too strongly condemned during the acute stage of this disorder, as they are likely to induce epididymitis and pyelitis.

If retention of urine becomes complete steps must be taken to relieve the condition. A trial should first be made to get the patient to pass water naturally. He is given 30 minims of laudanum by the mouth, and is put into a hot bath and told to pass his water in the bath if he can. The injection of the following solution into the anterior urethra may diminish congestion and spasm sufficiently to afford relief:

Adrenalin (1 : 1000)	♏iij
Cocaine hydrochlor.	gr. ½
Aq. destill.	ad. ℥j.

If these methods fail two courses lie open: the first is to perform supra-pubic aspiration of the bladder, the second is to pass a catheter. It is found by repeated experience that there is no risk of setting up cystitis if a catheter is passed, though there is some risk of setting up epididymitis, so that there is little to be said against the passage of a No. 10 English scale gum-elastic catheter with the utmost gentleness,

and there is seldom any need to pass it a second time as the retention is not maintained.

The Treatment of Abscess.

When abscess is merely suspected the case should be watched from day to day, as the best thing that can happen is spontaneous rupture into the urethra. After some undue or sudden exertion something is felt to give way in the perinæum, there is immediate relief of pain, and a profuse discharge of pus and blood from the urethra.

If an area of softening can be felt on the posterior wall it is certain that the abscess will burst into the rectum if left to itself. This is an undesirable event, as though often curative it is nevertheless attended with unpleasant complications, such as proctitis and urethro-rectal fistula. No more time should be lost and the abscess must be freely opened. The old methods of opening such an abscess into the urethra by passing a metal catheter or into the rectum are to be condemned. The perinæal route is the only right method of approach, but the exact method is a matter of choice.

(1) The simple method is to make an incision into the ischio-rectal fossa through the skin and superficial fascia an inch and a half long, starting one inch in front of the rectum and half an inch to the outer side of the middle line. With a gloved finger of the left hand in the rectum as a guide, a finger of the right hand is made to bore its way forwards into the roof of the extreme front portion of the ischio-rectal fossa beneath the posterior margin of the triangular ligament. The swollen prostate can then be felt and a pair of sinus forceps or a knife guided to the most prominent part, and made to enter the swollen gland until pus is struck. Several abscesses may require opening, and the loculi should be broken down with the finger and large tubes inserted and stitched in place.

An abscess may burst into the urethra while the rectum is being examined after the patient has been anæsthetised. If it does so there is no need to proceed with the operation.

Various other methods of approach can be used. Through an external urethrotomy wound a finger can be wormed into the prostatic urethra, and made to bore its way into the abscess, or the prostate can be exposed by the method of Proust and Young as for perinæal prostatectomy, and dealt with under the guidance of the eye.

CHAPTER IV.

CHRONIC INFLAMMATION OF THE PROSTATE.

Chronic prostatitis has not received much attention in England, but it is a most important condition to recognise as it is very common, is not easy to diagnose, is the cause of many obscure and troublesome symptoms, and if treated correctly the results are very satisfactory.

In the majority of cases of chronic posterior urethritis the prostate is affected, and if the disease persists for more than a year the prostate is found affected in at least 72 per cent. of the cases (Notthaft).

The gonococcus is the most frequent cause of the complaint. Young's list, based on the records of 358 personal cases, gives as a cause the gonococcus in 73·2 per cent., no cause known in 11·8 per cent., masturbation in 7·5 per cent., descending infection ·8 per cent., bicycling ·6 per cent., influenza 1 case.

In England a certain proportion of cases will be found to be due to riding on horse-back, though it is often hard to be certain that there has not been a previous specific urethritis.

Bacteria may reach the gland in the ways mentioned above (p. 362) and set up an acute inflammation which becomes chronic, or set up a chronic inflammation from the first. Notthaft found the gonococcus in 73 per cent. of the cases under a year old, in 6 per cent. over two years old, and in none after three years. Young examined nineteen chronic cases by improved methods and never found the gonococcus once; he found mixed cocci in six cases, and the rest were sterile. Anaërobic cultures might have yielded different results, as Jungano found that the majority of chronic cases of urethritis will grow anaërobes.

The pathological anatomy has been studied in detail by Young. The ducts are the parts chiefly involved, and there is a well-marked peri-ductal infiltration with round cells. Much depends on whether the ducts are blocked or not. If plugged, the acini become distended with secretion and purulent *debris* (follicular abscesses) and the gland is enlarged. If not plugged the acini show little change and

the gland is small—facts which throw light on the value of prostatic massage. In the earlier stages there is a peri-acinous round-cell infiltration, and the acini are full of epithelial *débris* and pus-cells; but later on the glandular tissue may undergo atrophy and the interstitial tissue multiply, so that the prostate is turned into a small, tough, diffuse mass of fibrous tissue (the fibrous prostate).

Symptoms and Diagnosis.

The symptoms are protean and extensive. The profession as a whole has not yet been instructed how to diagnose prostatitis, so that the condition is usually missed, with a result that the cause of many common symptoms is not treated. The best proof that prostatitis is the cause of widespread trouble is the rapidity with which the symptoms melt away if the prostatitis be cured by suitable treatment. The subject cannot be said to be unimportant, as the disease is one of the most widespread of all chronic diseases in large cities. The symptoms are urinary, sexual, and mental.

A. Urinary.

Micturition.—Increased frequency of micturition at night as well as by day is almost a constant sign, and the condition is made worse if the patient broods over it, as attention makes the calls more frequent. A bad habit of micturating constantly is formed, and has to be broken gradually by training the bladder-muscle.

A tickling sensation in the end of the penis is a common complaint and gives the patient no rest, or the urethra may feel damp at all times. The stream may be feeble, and partial retention with residual urine has been reported in the later stages.

Pain is widespread owing to the wide nerve supply of the prostate obtained from the segments of the cord, tenth, eleventh dorsal, and second and third and fourth sacral (Head), and to the fact that the affective tone of the nervous system is depressed so that the mildest stimulus may be felt as pain and may be referred to spreading areas.

In the milder cases there is a constant feeling of weight in the perinæum, which may become actual pain at times, especially after prolonged sitting or riding, and at the same time there is a feeling as of a foreign body in the rectum with attacks of tenesmus and pain during defæcation. A dull aching pain may be felt along the penis, or in the spermatic

cord and testicle and along the outer edge of the lower part of the rectus, suggesting renal calculus or appendicitis, or the pain may course down the back of the thigh and into the lower part of the sacrum and coccyx.

In a small number of cases a few drops of blood may be passed with the last few drops of urine.

B. Sexual Symptoms.

The passage of blood-stained sperm is a very characteristic feature of the disease, and the sperm may be yellow, green or pink, and fluid instead of transparent and jelly-like. Painful chordee at night is a troublesome symptom that can only be relieved by rising to micturate, and frequent nocturnal emissions cause the patient much annoyance and worry. Less common results are loss of sexual power, loss of sexual desire, impotence, prostatorrhœa and sterility.

C. Mental Symptoms.

Inflammation of the prostate has a profound effect upon the nervous system. The prostate is a highly sensitive organ, richly supplied with ganglion cells and sensory nerves, and its secretion is intimately controlled by the centres in the brain, which are concerned with sexual emotions and acts which consciously or sub-consciously play an important part in controlling the actions of the nervous system during adult life. Inflammation of the prostate seems to be able to depress the healthy action of the whole of this complicated system. The patient becomes hypochondriacal, and imagines that all sorts of evil things will befall him; he becomes convinced that he is impotent, and that his sexual powers are lost, and he may worry himself into a state of neurasthenia, becoming anxious, irritable, fearful, and a few such persons end in suicide.

This type must be carefully distinguished from the sexual hypochondriac who has never had gonorrhœa, and whose troubles are mainly due to sexual excess. The sexual glands are stimulated into a condition of continuous excessive secretion which pours out from the relaxed urethra, the mental condition being aggravated by poring over quack advertisements.

Physical Signs and Diagnosis.

The diagnosis is made as follows: The patient presents himself for examination having held water for at least four

hours. The anterior urethra (the part anterior to the compressor) is thoroughly flushed with boracic lotion (two pints, temperature 105° F.), placed in a douche tin raised five feet above the level of the penis, and connected to a urethral irrigator until the washings come away clear of pus and threads (see p. 282).

The patient is then directed to pass the major portion of his urine into two glasses and leave a little in the bladder. The first portion contains the washings of the posterior urethra, the second is clear if there is no cystitis. If the second is not clear the remainder of the urine is passed, and the bladder is filled with boracic lotion by hydraulic pressure, the sphincters having been paralysed with novocain and washed out until the fluid comes away clear. In most cases there is no need for this step, and in either case the next procedure is to empty the prostate and vesiculæ of their contents by rectal massage. The surgeon inserts a gloved finger into the rectum, the patient being in the knee-elbow position, and with gentle pressure he strips the vesiculæ and prostate of their contents. Specimens of the expressed fluid can be collected direct from the meatus, and the patient then passes the contents of his bladder and washes out the remainder of the expressed fluids into a test-glass.

The diagnosis depends on the character of the fluid so obtained.

(A) *In health* the sperm floats about in the form of large, translucent clots, and the prostatic fluid is seen as a delicate opalescent haze in the otherwise clear urine, and under the microscope the important thing to note is the comparative absence of polymorphonuclear leucocytes. A few red blood-corpuscles are found, and in addition pavement masses of epithelial cells with large ovoid nucleus, surrounded by a small ring of clear protoplasm; granular or vacuolated cells which contain large quantities of fat; lecithin bodies which are round, colourless, and generally smaller than a red blood-corpuscle; corpora amylacea; and from the vesiculæ spermatozoa and large mucinoid bodies that resemble sago-grains.

(B) *In disease* the sperm may be blood-stained, or yellow or green, the prostatic fluid is milky or obviously purulent, and the urine is full of opaque whitish-yellow flakes and tiny comma threads which are plugs from the mouths of the prostatic ducts. The threads and shreds consist of masses of varying proportions of epithelial cells and pus-cells glued together by mucus, and gonococci or other bacteria may be

demonstrated in them by suitable stains. A film made of the fluid itself shows little else but pus-cells in severe cases, which mask the other cells seen in health. The severity of the disease should be judged by the number of pus-cells and by bacteriological investigation. The fewer the pus-cells the less severe the inflammation, and the less likelihood of its being infective.

By means of stained films and on suitable media the presence of the gonococcus and other bacteria can be detected, but at least three or four such investigations must be carried out over an interval of some weeks if the gonococcus is suspected, and attempts must be made to bring out the lurking gonococcus by testing the patient after he has indulged freely in alcohol, hard riding, or after the instillation of strong silver solution into the deep urethra (1 per cent.).

The naked-eye diagnosis of diseased from healthy prostatic fluid can seldom be made with certainty. In all doubtful cases the microscope is the only test, and the two unhealthy signs are the presence of a large number of pus-cells and of bacteria.

Palpation of the prostate and vesiculæ usually reveals some alteration. It is seldom that the whole gland is enlarged, but often a portion is rounded, swollen and tender; in the later stages one or more small indurated areas can be felt deeply buried which are definitely more tender than the surrounding parts. Their usual situation is in the region of the vesiculæ. These hard areas are tough yet elastic, and are quite different to the stony nodules of carcinoma and the smooth rounded calculi or phleboliths.

The urine passed, apart from rectal massage, may contain threads, but it is surprising how that sometimes it may be found absolutely clear and yet massage reveals ample prostatic pus. Very tiny white comma threads that can only be seen in a good light are very suggestive of latent prostatitis.

Phosphaturia is common, and seems to be partly bound up with the worried mental state of the patient, but is also seen when the disease is clearing up or running a favourable course.

Bacteriuria appears not infrequently during a course of prostatic massage, but if the prostate is healed it rapidly yields to urotropin.

The urethroscope shows a turgid and inflamed verumontanum, and pus may be seen issuing from the prostatic ducts.

The Complications.

Chronic urethritis is present in 70 per cent. of the cases, either as a constant milky or transparent gleet with the passage of threads in the urine, or in the form of relapsing attacks of bright yellow urethral discharge, which comes on every three or four weeks or at longer intervals, while in between the patient imagines he is cured. A chronic prostatitis or a folliculitis is at the bottom of all such relapsing cases.

Vesiculitis is present in about half the cases, and one or both vesicles may be felt hard, enlarged and tender.

Epididymitis is especially apt to appear in the cases complicated with a vesiculitis, either flaring up acutely, or coming on insidiously, and giving rise to a chronic hydrocele. Many a chronic hydrocele and many a hard nodule in the epididymis are due to insidious infection from the deep urethra in the course of a chronic prostatitis, either by the gonococcus itself or by the colon bacillus and similar organisms.

In a certain number of individuals from the age of thirty-five and upwards the disease becomes very chronic, and leads to atrophy of the gland with diffuse fibrosis of the stroma. There is nocturnal increased frequency of micturition, difficulty in micturition, and partial or complete retention of urine, simulating the picture presented by a man with adenomatous prostate.

This form should be carefully distinguished from adenoma, and its existence has led to a great deal of confusion (see Ch. I, Sect. IV). It can appear in a man under fifty, and there is generally a gonorrhœal history. The prostate itself is small, tough, and fibrous, and surrounds the urethra like a hard collar, constricting it (the "collar prostate"). The cystoscope reveals a small hypertrophied bladder, a median bar lying behind the meatus rather than a lobulated structure, and the meatus itself regular and smooth rather than irregular and lobulated. The diagnosis is best made by palpation, which endeavours to discriminate between the stony hardness of carcinoma, the toughness of chronic inflammation, and the elasticity of an adenoma. This type of prostate is benefited by the passage of a large metal bougie, or by the operation of prostatotomy, which act favourably by dilating the deep urethra; it cannot be shelled out from its bed like an adenoma, as it is firmly attached to the true fascial capsule by dense fibrous bands.

In old men, therefore, the diagnosis is from the more common adenoma of the prostate and from carcinoma; in young men, from tuberculosis of the epididymis and prostate, and from many other conditions, such as renal colic, vesical calculus, sciatica, painful varicocele, appendicitis, and the causes of neurasthenia.

The diagnosis can seldom be in doubt if an accurate history be obtained, and the urethra and prostate be examined routinely by the modern methods of diagnosis before proceeding to examine the upper reaches, namely the bladder and kidney.

The chief clinical forms are:

1. The neurasthenic type with widespread pains, prostatorrhœa, and sexual phobias of all kinds.
2. The latent form with a slight gleet, increased frequency of micturition, obscure pains and chronic epididymitis.
3. The relapsing form with recurrent attacks of bright yellow urethral discharge.
4. The "prostatism" form in older patients, with signs suggesting an enlarged prostate.

Sterility is produced in 10 per cent. of the cases if they are unrelieved by treatment, and the condition is said to prepare the soil for the tubercle bacillus.

In a few individuals without venereal taint a primary prostatitis may arise apparently as a hæmatogenous infection, and may be followed by the appearance of a bright yellow urethral discharge. The disease is usually associated either with hard riding, or with mental overwork and phosphaturia. The discharge contains pus-cells, but no gonococci, and may contain other bacteria, such as the colon bacillus, or be sterile. It reacts promptly to treatment, but if riding be the cause it is very likely to return when the patient starts riding again, and in this way may prove a most troublesome complaint.

Treatment.

General.

Anything that tends to congest the prostate must be avoided, such as sexual excess, excessive horse-riding or bicycling, and alcohol. The depressed condition of the nervous system is met with cheerful suggestion and encouragement, tonics containing iron, quinine, and nux vomica, and, when possible, sea-air. Phosphaturia should be controlled by the exhibition of urotropin (gr. v) and acid sodium phosphate (gr. xxx, *t.d.s.*), a meat diet, and regular exercise.

LOCAL.

Treatment to be successful will take any time from two to six months, and the patient should be warned of this, and will need encouragement to persevere, but if the treatment be carried out conscientiously twice a week there are few cases that will not yield within six months or less.

The key to successful treatment is prostatic massage followed by irrigation of the posterior urethra. The patient passes water, his prostate and vesiculæ are stripped, a process which takes one to three minutes to perform, and the posterior urethra is then irrigated with a pint of lotion washed through into the bladder by hydraulic pressure (method of Janet, see p. 282). The best solution is one of potassium permanganate, strength 1 : 2000, and the changes may be rung with silver nitrate 1 : 10,000 and hydrarg. perchlor. 1 : 30,000. When the case hangs fire, the course may sometimes be cut short by employing instillations of strong silver nitrate after Guyon's method (strengths gr. j to gr. xx to 1 oz. of distilled water).

For a day before and after massage urotropin should be taken (gr. v. *t.d.s.*) as a prophylactic measure against the transient bacilluria that may be set up by the massage.

Young strongly recommends deep instillations of 2 per cent. carbolic in lanoline, especially for those cases where the feeling of the desire to micturate is constantly present, and silver nitrate is a sovereign remedy for the same complaint.

In rebellious cases a few dilatations with Kollmann's dilator may have a good effect, but it is an instrument to keep in reserve as much as possible as it sometimes sets up epididymitis or incontinence of urine, and in any case it should not be used when gonococci are still abundant, or when it causes great pain, and never till the prostatic fluid is nearly clear of pus-cells.

In the rare cases which go on for years until the symptoms of "prostatism" are produced, a course of the above treatment combined with regular catheterisation and passage of steel bougies should be carried out, if the diagnosis has been correctly made. If the condition fails to yield and if there is definite residual urine and other signs of obstructed bladder, it may be considered advisable to perform more radical measures. The regular passage of steel bougies should first be tried, and if this fails a perinæal prostatotomy or even partial prostatectomy may be performed. Young has reported some striking results in this connection.

CHAPTER V.

TUBERCULOSIS OF THE PROSTATE.

Ætiology.

THE disease may arise as a primary hæmatogenous infection, or be secondary to a primary tuberculosis of the epididymis or kidney. Authorities differ as to the relative frequency of each, satisfactory evidence being hard to obtain. Although evidence obtained at autopsy would point to the fact that primary infection does occur, yet clinically it is rare for a patient to present himself for examination with the disease still confined to the prostate alone. The truth may be that primary tuberculosis confined to the prostate causes no symptoms and does not bring a man to the doctor, so that it is seldom met with except in the post-mortem room in persons who have died of other diseases. *For practical purposes tuberculosis of the prostate is secondary to a tuberculous focus in the epididymis or in the kidney*, and the disease reaches the organ by local spread along the connective-tissue spaces. The age limits are those of puberty, twenty to forty years, when predisposing causes are at work, namely, excessive coitus and chronic urethritis.

Morbid Anatomy.

Miliary tubercles appear in patches throughout the stroma of the gland, become confluent, undergo necrosis and give rise to caseous nodules surrounded by tuberculous granulation tissue.

The gland is moderately enlarged, the surface irregular and nodular, and on section presents a number of pea-like cheesy deposits. If healing occurs these nodules become cretaceous and surrounded by a dense wall of fibrous tissue; but if the disease progresses the nodules soften into pus, which makes its way to the surface along fistulous tracks into the urethra, bladder, rectum, or skin of the perinæum and abdomen, secondary infection being the inevitable consequence.

The disease may spread by direct continuity to the vesiculæ, bladder and urethra; by means of the lymphatics to the pelvic lymphatic glands; or enter the blood to produce localised deposits in other organs or general tuberculosis.

Symptoms and Course.

Tuberculosis confined to the prostate gives rise to no symptoms in the majority of cases, the symptoms that bring the patient under observation being caused by associated disease in the testicle, kidney or bladder.

Blood in the sperm, pus in the sperm, painful coitus and increased frequency of micturition are rarely observed as early symptoms, but they are equivocal, and are more often due to other forms of chronic prostatitis.

As the disease spreads to the bladder it declares itself with pain during micturition and defæcation, increased frequency of micturition by night as well as by day, hæmaturia and cloudy urine. The pain and hæmaturia are similar to those of other forms of chronic prostatitis and cystitis (see Ch. IV, Sect. IV, and Ch. IV, Sect. III).

Physical examination.—The general health is unaffected in the early stages, though towards the end the picture is one of hectic fever, wasting and amyloid disease, but localised tuberculous foci are usually discovered elsewhere in the testicles, kidneys or lungs, etc., by the routine methods of examination.

Rectal examination reveals a moderately enlarged prostate with one or more irregular rounded nodules scattered throughout the gland, either on the posterior surface or buried deep in the glands. These nodules are firm in consistency, not of stony hardness, but more like that of a ripe pea, and softened areas can be felt when a cold abscess is forming. The prostate itself is not particularly tender, but in extensive disease extending to the bladder base rectal examination may cause great pain, or in other words a tuberculous prostate is not necessarily a tender prostate. The disease is often confined to one lobe of the prostate, and nodular tuberculous thickenings are nearly always present either in the vesicle and vas of the same side, or in that part of the ureter that can be felt by the rectum. Fistulæ may be met with leading from abscesses in the prostate to the skin of the perinæum or abdomen, or into the urethra and rectum.

Clinical Types of Onset.

The disease is usually encountered in the following ways:

(1) A young man free from venereal taint presents himself for examination because of a tender lump in one of his testicles, and routine rectal examination reveals nodules in the prostate.

(2) A young man complains of symptoms of irritable bladder, pain in the back of one loin, and the passage of cloudy urine, the disease being found in one kidney and ureter and corresponding lobe of the prostate.

(3) A young man who has suffered for some years from chronic urethritis and prostatitis which has defied all treatment finds his symptoms increasing in severity, and begins to pass blood and pus at the end of micturition. The prostate becomes nodular, and tubercle bacilli are found in the urine or prostatic secretion.

The course is prolonged over several years, and is marked by periods of latency. If the primary focus in kidney or testicle can be removed the nodules in the prostate may shrivel up into cretaceous masses well walled off by fibrous tissue, or even be absorbed altogether, so that it is possible to speak of cure, but the disease is very likely to be lighted up again by any indiscretion in sexual or general hygiene. More often the course is steadily downward, neighbouring organs becoming involved, and the patient is finally carried off either by secondary infections and associated toxæmia, or by the destruction of both kidneys from tuberculosis.

Diagnosis.

The diagnosis of tuberculosis of the prostate depends on the age of the patient (twenty to forty-five), a history of family disease or life passed in a tuberculous household, the character of the prostate itself as described above, the finding of foci elsewhere, especially in the epididymis, kidney, bladder, and vesiculæ, and the finding of tubercle bacilli in the prostatic secretion or the urine. It seldom presents much difficulty in secondary cases.

In a young man there are only two common causes of an enlarged prostate—chronic urethritis and tuberculosis. In chronic urethritis the venereal history is a guide, and the prostate in the early stages is enlarged evenly and is smoothly rounded off, and does not present the pea-like nodules and irregularities of tuberculosis. In the later stages, when fibroid indurations are left, these are not so hard or clearly

defined as tuberculous nodules, but appear to shade off into the softer prostatic tissue. Associated nodules in the epididymis are little guide, as they might have been due to the urethritis, but if a nodule in the epididymis has broken down and left a scar there is seldom much doubt that the disease is tuberculous.

The onset of the disease in the course of a case of chronic urethritis could only be suspected if tubercle bacilli were found in the prostatic secretion, if multiple hard nodules were detected by rectal examination, and by the detection of tuberculous foci elsewhere.

In men between forty and fifty the disease has to be distinguished from carcinoma, which is seldom difficult if the stone-like hardness of carcinomatous nodules be remembered, and their fixity to surrounding structures, especially if there are no tuberculous nodules elsewhere, and no pyuria or bacilluria.

A prostatic stone or a phlebolith, which, in addition to being stony, are smooth, rounded, and movable, should not be taken for a tuberculous nodule.

Treatment.

The same hygienic, dietetic, and tonic treatment should be adopted as in tuberculosis elsewhere (see p. 293), and in most cases all local interference should be avoided, especially any unnecessary urethral instrumentation with its risks of setting up secondary infection, nor is the use of instillations into the deep urethra advisable as recommended by the French school.

Pain and irritability of the bladder can often be controlled by the exhibition of sandal-wood oil, but in some cases suppositories of belladonna, antipyrin, and morphia may be required.

Retention of urine may necessitate the passage of a catheter.

For purposes of treatment it is necessary to determine—

(1) *The primary focus.*

(2) *The extent of the disease.*

The keys to successful treatment are:

(1) *Removal of the primary focus,* if the disease be unilateral in testicle or kidney.

(2) *Tuberculin vaccinations.*

It is so rare to meet with a case of pure primary prostatic tuberculosis that excision of the prostate itself for this

disease is seldom feasible, and those who have tried it report disappointing results. In the majority of cases the primary focus is in one testicle or one kidney, and it is found by experience that if this focus be removed the disease in the prostate tends to die out, though if both testicles or both kidneys be diseased it is too late for operation.

Suitable doses of tuberculin are given till the tuberculo-opsonic index is raised to well above the normal, when nephrectomy or orchidectomy may be performed, as much as possible of the ureter or vas being removed at the same time. The patient is then given tuberculin injections at regular intervals as detailed in Ch. IV, Sect. III, and under such treatment the results have been encouraging.

If a cold abscess appears it is of the utmost importance to prevent it from bursting on to an infected surface, with the production of a chronic fistula that is not likely to heal. Immediately an area of softening is detected the surgeon should cut down upon the prostate from the perinæum, evacuate the abscess, scrape its walls clean, flush it out with strong perchloride of mercury solution (1 : 200), and stitch the wound up completely *without drainage*. The wound should heal by first intention, and if the pus re-accumulates the process can be repeated as often as necessary till the abscess is cured.

CHAPTER VI.

PROSTATIC CALCULI.

Classification.

1. Of Prostatic Origin.
   a. Phosphatic concretions around "amyloid" bodies.
   b. Cretaceous deposit in a tuberculous mass.

2. Of Vesical Origin.
   a. Calculi impacted in the deep urethra.
   b. Calculi impacted in a prostatic abscess.

Primary phosphatic concretions.—The normal prostate from youth upwards contains minute sand-like bodies that lie free in the acini of the gland. These are rounded, colourless, yellow or black, resembling grains of sand or black pepper, and are of a gritty consistency. The name "amyloid" was given to these bodies as they give the amyloid reaction, that is to say, they turn blue with iodine and red with methyl violet. They consist of a structureless material deposited in concentric rings, a material which, according to Posner, consists of an albuminoid material and lecithin, the latter giving the amyloid reaction.

By the deposit of calcium phosphate and carbonate around these bodies as a nucleus stones of considerable size are sometimes formed. These stones may be single, but are usually multiple; they are smooth, rounded, and sometimes facetted, and are seldom much larger than peas; they are generally discovered only at autopsy in elderly people. They lie loose in cystic cavities, which contain a milky fluid, or in abscess cavities containing pus.

They usually lie latent and give rise to no symptoms, but they may set up chronic prostatitis with a feeling of weight in the perinæum or actual pain, increased frequency of micturition, and the passage of prostatic threads and pus. Rarely

they give rise to a chronic abscess, which may produce retention of urine, or burst into the rectum and set up a fistula.

The diagnosis is made by rectal examination and by the X rays.

The prostate feels enlarged and may be hot and slightly tender, one or more rounded stones being felt in isolated areas, or the whole gland may be turned into a bag of stones which grate and click together beneath the finger. An X-ray photograph shows a number of small shadows collected together in front of the bladder area.

The diagnosis has to be made from calcified tuberculous deposits, nodules of carcinoma, phleboliths and urethral calculi.

If the stones be causing symptoms of chronic or acute inflammation the prostate should be exposed by the perinæal route and the stones removed, or the prostate be removed as a whole.

SECTION V.

DISEASES OF THE URETHRA.

CHAPTER I.

STRICTURE OF THE URETHRA.

THE urethra in health is a collapsible tube which can be opened up by the passage of urine to a certain size. "A stricture exists where the urethra has lost its normal dilatability" (Sir Charles Bell). The dilatability of the normal urethra varies in different portions of the tube and in different individuals, but the average measurements are as follows:

	In diameter.	French scale.
The meatus, the narrowest portion,	7–8 mm.	No. 21–24
Penile portion	10 „	No. 30
Bulbous portion . . .	13–15 „	No. 39–45
Membranous portion . .	9–10 „	No. 27–30
Prostatic portion . . .	13–15 „	No. 39–45

An instrument, therefore, which will enter the meatus should pass with ease into the bladder, apart from spasmodic closure of the compressor urethræ muscle.

Ætiology.

Strictures may be—

1. *Organic;*
2. *Spasmodic and congestive.*

The spasmodic are temporary, and pass away if the cause be removed; the organic are permanent, and persist though the cause has been removed completely.

CAUSES.

1. *Organic stricture.*

A. Chronic gonorrhœal urethritis (90 per cent.).

B. Trauma—rupture.
—impacted calculi, caustic injections, burns from a hot sound.

C. Congenital pin-hole meatus, often combined with hypospadias.

D. Meatal chancre and chancroid.

E. Tertiary syphilitic infiltration, usually on top of a gonorrhœal stricture.

2. *Spasmodic stricture.*

A. Acute urethritis.

B. Reflex spasm from urethral instrumentation in patients of the neurotic type.

Organic Stricture due to Chronic Urethritis.

Pathology.

The gonococcus or secondary contaminating bacteria that follow in its train tend to linger on indefinitely at the end of an attack of acute urethritis in two situations.

1. In localised hyperæmic patches formed by subendothelial collections of round cells and bacteria in the penile and bulbous urethra.

2. In subendothelial patches around the mouths and walls of the crypts and mucous glands of the penile and bulbous urethra.

These patches may take many months or even years to heal, and in the process of healing spindle-cells appear and lay down fibrillar connective tissue, which as it grows thicker also shrinks like scar-tissue in any part of the body. The elastic fibres are destroyed and cannot be reproduced, the round-cells disappear, the blood-vessels pass into a condition of chronic arteritis, and the epithelial cells over the patch proliferate, degenerate, and finally become flattened and stratified. In this way a pale, smooth white scar is produced, which is tough and inelastic, and cannot be stretched without considerable force. By the time this stage is reached the gonococci have long ago been destroyed by the tissue-cells and fluids.

This scar may involve only a portion of the circumference of the urethra, when a partial narrowing is produced with the appearance of a white crescentic band or bridle stricture; or it may involve the whole circumference, when a tunnelled tortuous stricture is produced that may be as much as an inch long or even more. These scars can often be felt from the outside if the course of the urethra be palpated.

Situation of Strictures.

Sir Henry Thompson stated that 67 per cent. of strictures were found in the bulb, 17 per cent. in the first two and a half inches of the urethra, and 16 per cent. in the intermediate portions. Casper states that strictures never occur behind the entrance to the membranous urethra, but Young states that 70 per cent. are in the bulbo-membranous urethra, 23 per cent. in the pendulous urethra, and 5 per cent. in the glandular urethra. Strictures may be single or multiple, and if the urethroscope be used for diagnosis it is generally found that there are one or more strictures of large calibre in the penile urethra accompanying a more important stricture of small calibre deep in the bulb.

Anatomical Results of a Stricture.

1. *The urethra behind the stricture.*—This is pouched out and dilated by the increased urinary pressure, the mucous membrane being hyperæmic, sodden and unhealthy, and sometimes even ulcerated. The tissues surrounding this portion of the urethra and its glands, such as the glands of Cowper, become infected with secondary bacteria, aërobic and anaërobic (Jungano), with the production of diffuse indurations of the peri-urethral tissues or of cysts or abscesses deep in the perinæum. Such abscesses may burst into the urethra and heal up completely, or the urine may then make its way into the abscess cavity, giving rise to a localised urinary abscess or to a diffuse cellulitis or phlegmon ("extravasation of urine").

2. *The prostate, vesiculæ, and epididymis.*—These are often infected, and show evidence of acute or chronic inflammation.

3. *The bladder.*—The muscular walls undergo hypertrophy, and sacculation is produced (see Ch. I, Sect. IV). Cystitis occurs sooner or later, and may give rise to ulceration and calculus. Muscular atony with passive overflow is seldom seen.

4. *The ureters.*—These become dilated and their walls hypertrophied, and the mucous membrane may show signs of chronic inflammation.

5. *The kidneys.*—Nephrectasis is produced in neglected cases, leading to double hydronephrosis, or double pyonephrosis if infection is added.

6. *Cardiac and arterial muscular systems.*—If the kidneys are badly affected there is hypertrophy of the cardiac and arterial muscle-coats, with greatly increased blood-pressure, but in most cases this is a late complication.

Clinical Symptoms and Signs.

The patient is usually from twenty-five to forty-five years of age, and has had a urethritis within three to ten years before, but some patients deny having noticed any previous urethral discharge. In a few exceptional cases a definite organic stricture may come on within a month or two of the cessation of the urethral discharge, or its onset-symptom may be delayed for as long as thirty years after the last urethritis; but these cases are uncommon.

Difficulty in micturition is the most common onset-symptom noted by the patient. He finds that it takes him a longer time than usual to empty the bladder, or that the stream trickles out in driblets or drop by drop. He notices that he has to strain to force out the urine, the straining helping him considerably but producing a poor stream compared with the sense of effort required. The stream may be thin, or twisted or forked; but *forking is quite common in those who have no stricture*, and is caused by the swelling of the lips of the meatus commonly seen in a chronic urethritis, and has nothing to do with any deep stricture. In other words a *stricture should not be diagnosed merely because the stream is forked.*

Pain in the hypogastrium is produced if the straining is at all severe, but is usually absent.

The frequency of micturition is generally increased, especially in the day-time.

A gleety discharge from the meatus is almost a constant complaint, and is noticed especially in the mornings on rising.

Cloudy urine due to pyuria may be noted if the bladder has become infected, but in most cases the urine is clear save for a few muco-purulent threads which come from the urethra.

Complete retention of urine is another onset symptom that may bring the patient to the doctor, as some patients do not worry themselves about the other symptoms unless the hypogastric pain has been severe.

Complete retention is brought on by a drinking bout, or by exposure to cold, or by a voluntary forced holding of the water till a convenient moment, and is produced by congestion and œdema of the mucous membrane of the urethra and spasm of the peri-urethral musculature. *This is why it can be so often relieved by de-congestive and anti-spasmodic remedies without instrumentation.*

General Symptoms.

No effect is produced on the general health unless—

1. *The urine has become infected,* when the signs of cystitis and pyelo-nephritis are in evidence; or—

2. *The kidney has become affected by back-pressure,* when there is pain in the back of the loins and the symptoms of chronic uræmia.

Physical Signs and Diagnosis.

A tunnel stricture can usually be felt straight away by external *palpation* of the urethra as a dense, thickened cord in the line of the penile or bulbous urethra.

The urethroscope is the only certain instrument for the diagnosis of stricture. A No. 24 French scale tube with the obturator in position is inserted just within the meatus; the obturator is then removed, the eye-piece placed in position, air is pumped in, and the tube is slowly passed down the ureter under the control of the eye. Strictures of large calibre may be seen as glistening white crescentic bands partially surrounding the urethra that cannot be obliterated by air distension. A tunnel stricture is seen as a minute clean-cut orifice surrounded by a bright white in-folding or thickening of the urethral wall.

If a urethroscope is not to hand the diagnosis must be made with a *bougie,* but unless the urethra be carefully anæsthetised with novocain the bougie may come up against a tightly contracted compressor urethræ, which will give a false impression that stricture is present when the only trouble is a reflex spasm of the muscle.

Precautions to be Observed in the Passage of a Bougie.

1. Examine the urethra for fresh yellow discharge to exclude acute gonorrhœal retention.

2. Examine the nervous system for early signs of tabes and disseminated sclerosis.

3. Examine the rectum for signs of inflammation or growth of the prostate.

4. Sterilise the bougie, cleanse the hands and the glans penis, and finally, wash out the anterior urethra carefully with an irrigator and urethral nozzle (Janet's method) using a mild antiseptic lotion such as boracic or mercury oxy-cyanate 1 : 4000 (see p. 282).

5. Anæsthetise the urethra with an injection of thirty

minims of 2 per cent. novocain solution held in for three minutes to prevent spasm and shock.

6. Always start with a full-size instrument, No. 10 English or No. 24 French scale. A small instrument will miss strictures of large calibre and is more likely to set up spasm.

7. Use either a soft olive-headed gum-elastic bougie, or a steel sound. The acorn-headed bougie is not needed at the present day, but it was required in the past to measure the length of a stricture for future guidance in the old-fashioned operations of internal urethrotomy.

8. If the full-size instrument will not pass, work gradually *downwards* till an instrument is found that will pass, but dispensing with steel instruments below No. 7 English scale.

9. Note the number of strictures, their calibre, their distances from the meatus, and their character, whether soft and resilient, or tough, hard, gritty and tortuous, remembering the average measurements of the urethra—the anterior six inches, the membranous three quarters of an inch, the prostatic one and a quarter inches.

In this manner the diagnosis is made from other causes of urethral obstruction and retention of urine (see p. 401).

The age limits give a rough but useful guide to cases of urethral obstruction or complete retention of urine. The decade from 25–35 is the age of stricture, that from 35–45 is the age of stricture or tabes, that from 45–55 is the age of enlarged prostate.

The Dangers of Urethral Instrumentation.

1. Shock.
2. False passages.
3. Hæmorrhage.
4. Infection.
5. Suppression of urine.

1. *Shock.*—The symptoms of shock may come on either at once as a rapidly passing syncope due to inhibition of the heart for a few beats, or as a more prolonged depression caused by a gradual and persistent fall in the blood-pressure. Both can be prevented by "nerve-blocking," that is to say, by de-sensitising the urethra with novocain before instrumentation.

2. *False passages.*—Hæmorrhage is the most certain sign that a false passage has been made, and the bougie may be felt to sink into the false passage with a peculiar fine grating sensation.

If there is no urgent necessity for passing an instrument at the time, the surgeon should desist from further efforts, and leave the urethra alone for a week, as false passages heal readily in that time. If it is necessary to proceed further attempts may be made to circumvent the false passage by filling it up with fine bougies and so getting another instrument past it, or the urethroscope may be made use of and the bougie made to enter the stricture under control of the eye. If the bleeding be severe and the retention requires instant relief, supra-pubic puncture had better be performed, and repeated if necessary for some days, the patient being kept in bed.

3. *Hæmorrhage* is always due to a false passage, but is seldom dangerous. If it becomes profuse and alarming it may generally be controlled by the injection of hazeline or of adrenalin solution 1 : 10,000, or if in the penile urethra by arranging for gentle lateral compression of the urethra at the spot by means of strips of wood wrapped in a bandage. Care must be exercised not to compress the penis too tightly and produce a cold venous congestion.

4. *Infection or catheter fever.*—This is due to bacterial infection, and the absorption into the blood of bacteria or their poisons. It often occurs in men whose urine is clear before the passage of the instrument, and especially after the first instrument.

In the simplest form a rigor occurs a few hours after the instrumentation, and is accompanied by a rise in temperature to 102°–103° F. and the ordinary febrile signs. In one, two or three days the temperature returns to the normal and the patient is completely restored save that his urine now contains pus and bacteria.

In the more severe types the rigors are recurrent and a swinging temperature may persist for days or even weeks, and in exceptional cases suppression of urine comes on gradually and may lead to death with all the signs of acute uræmia.

To prevent rigors not only should the hands and the instrument be sterilised as is ordinarily done, but the urethra should be cleansed by urethral lavage, before instrumentation, and the patient should be kept quiet in a warm bed for some hours after the first instrumentation. Patients seldom if ever die in a rigor, which should be met by wrapping the patient up in warm blankets and giving him half an ounce of gin or brandy followed by quinine in five-grain doses.

Prognosis.

If a stricture is detected early in its course before it has had time to work mischief on the bladder or kidneys, suitable treatment can entirely prevent any harmful effects, and the patient is hardly any worse off as regards life than a healthy man, save for the very slight risks attendant on treatment. The evil effects of a stricture are to be warded off by early diagnosis. If the stricture be neglected it slowly destroys the kidneys by back-pressure and secondary infection, until at length it may put an end to life from uræmia, septicæmia, suppression, or extravasation of urine.

Treatment.

1. Simple stricture.
2. Complicated stricture—Retention.
   —False passage.
   —Cystitis.
   —Peri-urethral abscess.
   —Extravasation and cellulitis.
   —Catheter fever.

1. Treatment of Simple Stricture.

The choice lies between dilatation and some form of cutting operation.

A. *Dilatation* is undoubtedly the method of choice for those who can attend regularly for treatment and do not wish to leave their work, as it is the safest method in expert hands, Young, for instance, reporting 295 cases with no deaths, and if properly carried out it will cure completely in 70 per cent. of the cases (Young). It is especially valuable for soft bulbar strictures. It is contra-indicated if the urine is badly infected, and for resilient strictures in the penile urethra which contract down rapidly again and again in spite of dilatation.

B. *Internal urethrotomy.*—This is the method of choice for those patients, such as sailors, who cannot attend regularly for treatment, yet who can afford to lie up for a week and obtain relief. It is also indicated for all strictures when the urine is badly infected, so as to permit of immediate release of raised bladder tension and proper drainage by a catheter *à demeure*; for cases of resilient stricture in the penile urethra; and when it is desired to proceed at once to some manipulation on the bladder such as lithotrity or cystoscopy.

It is contra-indicated for deep bulbar strictures if they react well to dilatation, as there is some slight risk of severe

hæmorrhage, but the dangerous hæmorrhage is hardly ever met with at the present day after the modern operation with a Maisonneuve's urethrotome cutting on the roof.

c. *External urethrotomy.*—The indications are:

1. For impermeable stricture (Wheelhouse's operation).
2. Perinæal abscess and fistula. } Syme's operation or internal urethrotomy followed by median perinæal cystotomy.
3. "Extravasation of urine." } Syme's operation or internal urethrotomy followed by median perinæal cystotomy.
4. Very severe cystitis for purposes of drainage. } Syme's operation or internal urethrotomy followed by median perinæal cystotomy.

Intermittent dilatation.—The same care is taken to avoid sepsis as in the passage of the first instrument (see above), and the patient should take urotropin (gr. v) three times a day, beginning on the day before and finishing the day after the operation.

Dilatation should not be performed more than twice a week, and it is useless to be in a hurry, as if the stricture is forcibly torn or made to bleed it will only prove more rebellious of cure. At each sitting a start is made with that size of instrument which was inserted last at the previous sitting, and a gain of 2 to 4 sizes on the French scale is quite sufficient for any one sitting. Harm is done by endeavouring to run the stricture up many sizes at a time. It is safer if the urethra is washed out with antiseptic lotion at the beginning and again at the end of each sitting, Janet's method being used if there is no false passage, and such a lotion as boracic or oxycyanate of mercury 1 : 4000.

Olive-headed gum-elastic bougies are used till a size of about No. 18 French is attained, after which short straight or long steel bougies are used, the best pattern being Buxton Browne's modification of Sir Henry Thompson's bougies, which are two sizes larger in the curved portion of the shaft than at the top, and are marked 7/9, 8/10, etc., on the English scale. Start is made with a 7/9 and the process is continued for some weeks until a No. 15/17 can be passed. To maintain the urethra at this calibre a 15/17 is passed once a week for a month, once a month for six months, and twice a year for the next few years. In this way the urethral passage is kept widely open, and no harmful back-pressure effects can be produced on the kidney.

Internal urethrotomy.—The patient is prepared for operation for three days with urinary antiseptics, urethral washes and a proper emptying of the colon to prevent bacterial infection. The best type of operation is that performed with Maisonneuve's

urethrotome, which cuts on the roof of the canal from before backwards. Steel bougies are passed after the cutting to stretch the canal thoroughly, and a catheter is tied in for forty-eight hours. The urine is kept clean by the exhibition of urotropin, copious drinking of bland fluids, and vesical lavage if required.

The patient rises from bed on the sixth morning, and on the sixth evening he is taught to pass a 12/14 English steel bougie or a No. 24 French gum-elastic bougie on himself, being instructed how to keep the bougie clean, and on the seventh day he can resume his ordinary life.

If hæmorrhage should prove alarming after the operation, the site of the hæmorrhage can be determined by pressing on the perinæum and along the sides of the penis, and finding at what point pressure stops the hæmorrhage.

If the hæmorrhage is penile it can be controlled by applying gentle lateral pressure to each side of the penis with strips of wood wrapped in lint and fixed by a bandage. If it is bulbar the foot end of the bed should be raised on six-inch blocks and continuous pressure be applied to the perinæum.

If these measures fail an external urethrotomy must be at once performed, and the bleeding point controlled, if possible, by catgut ligature, but if not by means of a full-sized evacuator tube passed into the bladder and surrounded at the point of the bleeding with a bit of flat sponge or gauze soaked in adrenalin solution (1 : 1000). Strong styptics, such as perchloride of iron, should not be applied to the urethra.

Treatment of Complications.

1. *False passages* (see p. 389).

2. *Cystitis.*—Internal urethrotomy followed by drainage by catheter *á demeure* or a tube placed in an external urethrotomy wound, followed by lavage and a course of urinary antiseptics.

3. *Epididymitis.*—During the acute stage all interference with the urethra should be avoided whenever possible.

4. *Catheter fever* (see p. 389).

5. *Peri-urethral abscess and fistula.*—A peri-urethral abscess takes origin in the numerous mucous glands which surround the urethra. The duct becomes blocked, and the gland distended with purulent secretion can then be felt as a rounded swelling lying in the tissues on the outer side of the urethral wall. These swellings may be felt as pea-like nodules

on the floor or roof of the penile urethra, or as large swellings deep in the perinæum (Cowper's glands).

The pus makes its way out by bursting in *three* directions:

1. *Into the urethra.*
2. *On to the skin.*
3. *Into the surrounding tissues.*

A variety of different conditions can thus be produced.

1. PENILE URETHRA.

A. Lined by epithelium—closed cyst.
—internal sinus.
—external sinus.
—complete fistula.

B. Lined by granulation tissue.
—acute circumscribed abscess.
—abscess with internal or external openings.
—fistula.

Treatment.—Cysts need to be treated through the urethroscope. Abscesses must be opened internally through the urethroscope, or if pointing on the skin, by external incision.

Fistulæ lined by epithelium require to be scraped out and dressed with gauze, any stricture present being cut at the same time and kept dilated, when the fistula will slowly heal.

2. PERINÆAL ABSCESS.

A. *A closed cyst-like swelling of Cowper's gland.*—The best treatment is excision.

B. *A circumscribed perinæal abscess* lined by granulation tissue, acute or subacute.

The abscess should be opened in the middle line of the perinæum, a tube inserted and fomentations applied for a few days, after which the stricture usually present is divided by internal urethrotomy and kept opened with bougies. Healing generally occurs rapidly.

C. *A "urinary" abscess.*

The abscess has burst in the urethra but is unable to evacuate itself completely. The cavity fills up with urine during each act of micturition, and slowly empties itself after the act.

The abscess should be opened in the middle line and drained, and the accompanying stricture be treated by immediate internal or external urethrotomy.

D. *Perinæal fistulæ.*

The stricture is cut by internal or external urethrotomy and all the fistulous tracks are followed up, scraped out and drained.

Diffuse Gangrenous Cellulitis of Urethral Origin ("Extravasation of Urine").

This condition appears to take origin in several different ways:

(1) *It may arise insidiously* in any part of the urethra as an infection of the peri-urethral glandular tissues (glands of Littré, Cowper's glands) with virulent bacteria, aërobic, such as the colon bacillus, and anaërobic, such as the Bacillus perfringens (Jungano, Motz, Albarran). A long-standing chronic urethritis with Littritis or Cowperitis has existed previously with or without stricture formation, and the urine is usually alkaline and foul. These infected glands may lie dormant for years in the peri-bulbar and peri-membranous urethral tissue, but if they become secondarily infected with certain virulent bacteria a diffuse serous cellulitis is set up with the formation of gas and gangrenous sloughs, but the fluid in the tissue is not urine, and urine continues to be passed by the urethra. This form may occur apart from stricture, or may arise *in front of* a stricture and the urethra is often found intact, nor does the infiltrating fluid contain urine. The condition depends on the nature of the infecting bacteria.

(2) *It may appear suddenly* in a man who is straining to pass water through a tight stricture, the softened dilated urethra giving way just behind the stricture and allowing the urine to pass into the tissue, so that the tissues come to contain urine, and little if any urine is passed by the urethra after the accident.

(3) It may appear suddenly in a man who has had a perinæal abscess for some little time which fills up with urine during micturition, and slowly empties itself afterwards ("urinary abscess") from rupture of the walls of the abscess and extravasation of urine.

The fluid in the tissues, whether serous alone or serous and urinous, may spread in one of three directions, according as it takes origin from the urethra in front of or behind the anterior layer of the triangular ligament.

(1) It may advance in front of the triangular ligament into the pouch formed by Colles's fascia as it sweeps round beneath the transversus perinæi muscles to fuse with the triangular ligament. Colles's fascia guides it forwards into the scrotal and penile subcutaneous tissues and then on to the front of the abdomen.

(2) It may run backwards into the ischio-rectal fossæ to form a collection of fluid completely encircling the anus.

(3) It may spread backwards and upwards into the pelvic cellular tissues, into both groins, into the cave of Retzius, and along the ureters into the peri-renal fossæ.

Bacteriology.

Jungano states that in 13 per cent. of the cases he found anaërobes alone, in 75 per cent. anaërobes combined with aërobes, such as the *Bacillus coli* and streptococci. The *Bacillus perfringens* was the most common organism met with. The foul odour is due to the anaërobes. He thinks that the anaërobes play the most important *rôle*, and that they are at once destroyed by the letting in of air into the tissues by free incision.

Clinical Course.

The clinical types met with vary according to the pathogenesis.

(1) *The onset is insidious* in a man who has suffered for a long time from symptoms of stricture or chronic urethritis accompanied by chronic cystitis. The urine becomes alkaline and very foul; the man feels extremely ill, and notices a painful swelling in the perinæum, yet he is still able to pass a certain amount of water by the urethra. The condition is one of peri-urethral gangrenous cellulitis.

(2) The onset is sudden in a man who has had great difficulty for some time in forcing his urine through a tight stricture, the urine being infected and purulent. While straining to pass water he feels a sudden relief from his hypogastric pain, accompanied by a feeling of something having given way and of distension in the perinæum. No urine is passed yet his bladder feels relieved. The condition is one of extravasation of urine, and is shortly followed by gangrenous cellulitis.

(3) The onset is sudden in a man who has suffered for some time from a "urinary abscess."

In the severest cases the body is overwhelmed by the toxæmia, the temperature is persistently subnormal, the pulse feeble and rapid, the skin clammy, cold and pale, and death occurs in two or three days.

In the less severe cases there are all the signs of reactionary fever, the temperature being raised and the course of the

disease being marked by recurrent rigors, and even in the absence of treatment the patient may survive for a week or more, but eventually he will succumb to septicæmia.

The diagnosis is made after noting the dangerous toxæmic state of the patient by inspection and palpation of the perinæum, scrotum and abdomen.

The tissues of the perinæum, scrotum, penis and abdomen are distended with fluid, hot, dusky-red and tender. In advanced cases green or black gangrenous subcutaneous sloughs may show through the skin, and the presence of gas is revealed by a sensation of emphysematous crackling or the appearance of gaseous bullæ. Last of all the subcutaneous tissue and skin may slough clean away, leaving the testicles and penis denuded and covered with unhealthy granulation tissue.

There is no need to pass a diagnostic bougie, as the diagnosis should be quite evident without, and a stricture is not invariably present as the cause of the trouble. With the patient in such a bad state any unnecessary instrumental interference is to be deprecated. Death is almost invariable within two to eight days if the condition remains untreated, but with prompt and accurate treatment the results are more encouraging, and however bad the patient appears to be, surgical treatment should always be adopted.

Treatment.

The patient is anæsthetised and placed in the lithotomy position. An incision is made in the middle line extending from the back of the scrotum to within a inch of the anal margin. The front part of the incision is deepened until the foul effusion is reached beneath Colles's fascia. A finger is inserted into the wound to break down loculi and release sloughs, and feel for any opening into the urethra. If this can be found a full-size rubber catheter is passed into the bladder and stitched into the perinæal wound, any stricture being left alone to be dealt with some weeks later. If it cannot be found a Syme's or a Wheelhouse's external urethrotomy is performed, the way into the bladder found, and a catheter tied into the perinæal wound as before.

Free incisions two inches long are then made into the infiltrated tissues on either side of the middle line of the perinæum, into the skin of the scrotum, penis and abdomen, sloughs being scooped out as they are met with. No tubes need be inserted, as drainage is free enough without them if

a sufficient number of incisions be made. The wounds are dressed with large hot boracic fomentations, and during the day-time the patient should sit for some hours in a hot hip bath, the water of which is constantly changed. Every effort must be made to support the failing strength of the patient, and he should be dosed with urinary antiseptics and quinine, and the bladder should be washed out twice daily.

CHAPTER II.

RUPTURED URETHRA; TRAUMATIC STRICTURE.

SUBCUTANEOUS rupture of the urethra is usually met with in boys who have been trying to walk along the top of a fence and have fallen astride it. The urethra is driven forcibly upwards or outwards against the pubic arch and torn across just as it pierces the triangular ligament in the region of the bulb. It is also met with occasionally in crush fractures of the pelvis, when the membranous urethra may be torn across.

The rupture may be partial, or complete, and when the urethra and corpus spongiosum are both torn completely, blood and urine are effused into the tissues around the corpus spongiosum.

As a general rule when the rupture is in the neighbourhood of the triangular ligament the fluid comes forward beneath the fascia of Colles and upwards into the skin of the scrotum, penis and abdomen, so that the limits of the fascia become marked out by a plum-coloured "bruise."

Symptoms, Diagnosis and Treatment.

The history.—The patient has fallen astride a fence or a beam.

Bleeding urethra.—Blood is found to be dribbling from the meatus apart from micturition. If the rupture is complete micturition is usually impossible, if incomplete the urine passed contains clots. There are signs of effusion of blood in the perinæum, and if the patient has micturated there may be quite a large collection of fluid in that position, but more usually the bladder is distended with urine, and painful from retention of urine. In neglected cases a large collection of blood and urine appears in the subcutaneous tissues of the perinæum and comes forward beneath the skin of the scrotum and penis; infection is seldom long delayed and sets up a gangrenous cellulitis leading to death from septicæmia.

Such a patient should be placed under a general anæsthetic without delay, before any attempts are made to sound him.

When he is safely anæsthetised, an attempt should be made to pass a soft red rubber catheter of a size just large enough to enter the meatus. If it passes into the bladder it means that there is only a partial rupture, and there is then no need to proceed further. The catheter is tied in, and left for seven days.

If it does not pass an attempt should be made to insert a round-nosed black gum-elastic catheter, and if this fails the catheter is left in the urethra as far as it will go, the patient is placed in the lithotomy position, and a median perinæal incision carried straight down till the tip of the catheter is exposed. In this way the distal end of the urethra is found.

The wound is now sponged out and the hæmorrhage controlled, after which the proximal end of the urethra has to be searched for. When it is found the catheter is passed into the bladder and the torn urethra is reunited round the catheter by fine catgut sutures. The catheter is tied in and is left for seven days *in situ*. The perinæal wound is left open to permit of free drainage.

If the upper end cannot be found after a prolonged search, then it is wiser to desist and simply insert a large drainage-tube into the perinæal wound, and allow the urine to drain away in that way for some days. A second operation a few days later is more likely to prove successful when the bruised and torn tissues have recovered a little.

After-Treatment.

A most rebellious stricture will form at the site of the junction if immediate steps be not taken to control it. On the eighth day the catheter is removed, and a steel bougie of a corresponding calibre gently passed into the bladder. This is passed every day for three days, then once a week for a month, once a fortnight for a month, and then once a month for a year, and twice a year for the rest of life. If this treatment be not carried out a stricture forms, rapidly contracts down to a narrow gauge, and sets up back-pressure changes on bladder and kidneys.

CHAPTER III.

HOW TO DEAL WITH A CASE OF RETENTION OF URINE.

CASES of retention of urine present themselves in three different forms:

1. *Painful retention.*
2. *Painless retention.*
3. *Painless incontinence.*

1. PAINFUL RETENTION.

The patient complains that he has been unable to pass any water for many hours, and is suffering great agony from attacks of cramp in the hypogastrium which come on every few minutes and last a variable time. In between the attacks he has a feeling of weight and a dull aching pain in the hypogastrium.

There can seldom be any doubt of the diagnosis, and it is at once confirmed by abdominal palpation, which reveals a tense, pear-shaped cystic swelling above the pubes yielding a dull note to percussion.

The younger the patient, the better the state of his general health, the more recent the cause of the retention the greater is the pain, which means still active bladder-muscle. Pain, therefore, is of good prognosis.

2. PAINLESS RETENTION.

This type is seen in patients who are prostrated by a severe toxæmia, for instance in the course of typhoid fever, when the bladder-muscle becomes poisoned and relaxes completely. No pain is complained of nor is the patient in a fit enough mental state to notice that he has not been passing urine, so that the condition will be missed unless a daily note of the urine and a daily inspection of the abdomen be made in typhoid fever and similar debilitating illnesses.

3. Painless Incontinence.

The patient complains that he cannot hold his water for more than a few minutes, but that only a small quantity is passed every time, and he has no pain. The diagnosis is easy *if it be remembered that true incontinence is rare, and that incontinence is usually false or due to retention of urine with overflow.* Abdominal examination reveals a large toneless bladder extending upwards almost to the umbilical level. This form is especially met with in men with nervous disorders or with enlarged prostates.

Diagnosis.

1. *The distended bladder.*
2. *The cause of the distended bladder.*

1. The Distended Bladder.

This forms an elastic rounded swelling rising upwards immediately above the pubes towards the umbilicus, and yielding a dull percussion note. It usually occupies the middle line, but in chronic cases the peritoneum may become adherent to its outer surface in front so that nearly the whole organ is intra-peritoneal, and it may then lie to one side or other of the middle line, and in one case we have seen it missed because coils of gut lay in front of it. Pouches and diverticula may cause it to assume abnormal forms, rounded or conical projections being felt on one side or other, so that the shape is not always characteristic. A distended bladder is the commonest swelling met with in the hypogastric region, and has to be distinguished from the other tumours of that part, especially the pregnant uterus, uterine fibroids and ovarian cysts, and less common ones such as collections of pus, urachal cysts and growths of the cave of Retzius.

In cases of doubt the passage of a catheter will settle the diagnosis.

2. The Cause of the Distended Bladder.

Common causes.

In males : Stricture.
Enlarged prostate.
Tabes.

In females : Retroverted gravid uterus.
Pelvic tumour.
Disease of the nervous system—tabes, disseminated sclerosis, hysteria.

In children : Phimosis.
Impacted urethral calculus.
Spasm.

LIST OF POSSIBLE CAUSES.

A. URETHRAL OBSTRUCTION.

1. *Inside the tube.*—Calculi, bladder tumours, foreign bodies.
2. *In the wall.*—Stricture, urethritis, rupture, abscess, tumour.
3. *Outside the wall.*—Enlarged prostate, pelvic tumour, phimosis, ligature.

B. FAULTY BLADDER-WALL.

—*muscular atony* from over-distension.
—*poisons,* acute specific fevers, belladonna, lead.
—*nervous disease,* tabes, cord lesions, brain lesions, hysteria.
—*reflex,* after operations, etc.

The cause is discovered by a routine examination to exclude all but one of these causes, note being taken of the history, the nervous system, the abdomen, the perinæum and pelvis (rectal and vaginal examination), and, *finally,* an examination of the urethra is carried out by means of a catheter or bougie (see pp. 278 and 387).

Treatment.

For purposes of treatment the cases should be divided into two groups: *the acute* or recent, where there are no back-pressure changes, and so little danger in passing a catheter; *the acute on chronic,* where the cause has been of long standing and there has been time for back-pressure to affect the kidneys, so that the relief by catheter presents no little danger of setting up infection or even suppression of urine.

This can often be determined at once if the cause be known, and in any case an examination of the blood-pressure will yield valuable evidence, as if it is much raised, say to 150–200 mm. of mercury, it is very fair evidence that the kidneys are widely affected.

1. *Common causes of acute retention:*
   Acute urethritis.
   Retroverted gravid uterus.
   After operations.
   Impacted urethral calculus.
   Hysteria.

2. *Common causes of acute on chronic retention:*
   Enlarged prostate.
   Stricture of the urethra.
   Nervous disease.

In the first group there is no risk from emptying the bladder completely, but in the second group the patient should always be confined to a warm bed before a catheter is passed, and the urine should be drawn off slowly, as the bladder must never be emptied suddenly and completely when there has been long-standing back-pressure.

In acute cases on a chronic cause the final complete retention is due to congestion and spasm, so that the first step is to attempt to influence these, and *in this way most cases can be relieved without the passage of a catheter.*

An adult is given thirty minims of laudanum by the mouth, or a suppository containing half a grain of morphia, and is then placed in a hot bath, in which he lies for twenty minutes if the heart will stand it, and is instructed to pass his water into the bath. An additional remedy of value is to inject into the urethra thirty minims of the following solution:

Cocain. hydrochlor.	gr. ½.
Adrenalin hydrochlor. (1 in 1000) .	♏iij.
Aq. destill.	♏xxx.

If these measures fail to relieve a catheter must be passed without further delay.

A. *In cases of stricture* start with a No. 10E olive-headed gum-elastic *catheter* and work down to No. 4E. If none of these will pass lower sizes of gum-elastic *bougies* must be tried, and if these fail catgut or whalebone urethrotome guides. If a fine bougie is passed it should be left in for twelve hours, as urine will gradually dribble out along the sides of the bougie, and when the bougie is removed it is usually found that a much larger size of bougie or catheter can be passed (No. 4E), and if not that the stricture can be dilated up to No. 8–10F.

If the urine is foul and the patient's condition bad it may be better to perform an internal urethrotomy or even an external urethrotomy straight away, so as to permit of free drainage of the bladder, but in other cases intermittent gradual dilatation may be carried out (see Ch. I, Sect. V).

If there are many false passages or if a catheter cannot be passed supra-pubic puncture must be performed.

Supra-pubic puncture.—The pubic skin is shaved and

rendered surgically clean. The bladder must be distinctly felt before proceeding further, as it is not safe to trust to percussion. Take a *straight pleural needle* that has been boiled, and feeling for the bladder with one hand, plunge it straight inwards and slightly downwards into the bladder just above the pubes. The urine can be drained off by syphon action, a long rubber tube being attached to the end of the needle and allowed to hang over the edge of the bed, or by means of an aspirating bottle or a Dieulafoy's aspirating syringe. Before withdrawing the needle squirt a little boracic lotion through it to empty it of septic urine, withdraw it quickly and cover the puncture with gauze and collodion. Supra-pubic puncture may be repeated as often as required till further help can be obtained.

B. *In cases of enlarged prostate.*—A No. 8E gum-elastic *condé* catheter should be passed, and *not more than sixteen ounces of urine drawn off*, or a No. 4E catheter can be passed and tied in so that the urine comes away slowly. The bladder should never be emptied suddenly and completely by way of the urethra.

If sixteen ounces are withdrawn every four hours the bladder will be emptied in one to two days, when the question of further treatment must be considered (see Ch. I, Sect. IV).

If there are false passages or a catheter cannot be passed, supra-pubic puncture must be performed.

If there is clot retention the best course is to open the bladder by supra-pubic incision, lift out the clots, control the bleeding point and establish supra-pubic drainage (see Ch. I, Sect. IV).

C. *In acute gonorrhœal cases.*—If the preliminary de-congestive measures fail to relieve the condition, a catheter should be passed and the urine be withdrawn.

D. *For retroverted gravid uterus.*—A catheter should be passed at once, de-congestive remedies being useless, and the patient be kept in bed and watched. A catheter is passed every four hours, and in a day or two the uterus will usually right itself, but if it fails to do so it must be replaced in proper position by manipulation. If this cannot be done premature labour may have to be induced.

E. *For impacted calculus.*—The stone can usually be pushed back into the bladder and dealt with by litholapaxy.

F. *After operation.*—Little urine is secreted during the first twenty-four hours after an operation, owing to the low blood-pressure and the thirst of the tissues for water, so that there

need be no hurry to pass a catheter. If the patient is unable to gratify a desire to pass water, if the bladder causes pain and if it can be felt to be distended, hot fomentations should be applied to the hypogastrium and a hot enema of soap and water administered. If urine is not passed within an hour a No. 10E rubber catheter that has been boiled must be passed and the condition relieved. In certain highly strung patients this process may need to be repeated for a week or ten days after an operation.

G. *In hysterical cases* (*functional retention*).—The diagnosis is often difficult, as the practitioner may not feel sure that there is not some anatomical cause at work which he has failed to detect either locally or in the nervous system.

The condition is almost confined to females of neuropathic stock. Though the bladder may be greatly distended it appears to cause little pain or inconvenience.

A catheter must be passed to confirm the diagnosis from ovarian cyst and the bladder emptied. Very often the condition will not recur, but if it does so the next step is to administer a watery purge such as the pulv. jalapæ co., when the bladder may be emptied at the same time as the bowel.

If this fails the bladder cannot be left in a state of overdistension, so that a catheter will have to be passed twice a day, while arrangements are made for some form of treatment by suggestion.

CHAPTER IV.

CATHETERS AND BOUGIES.

THE catheters in common use are made of rubber, gum-elastic, or silver plate.

Bougies are made of gum-elastic, steel, whalebone, or catgut.

Gum-elastic instruments are woven out of fine silk or thread, and the gum-elastic varnish is then worked into them. They vary in pliability with the colour of the varnish, and may be bright yellow, brown, red, or black.

There are two scales of measurement. The English scale is an arbitrary scale and runs from 1 up to 16. The French scale is named after Charrière, and each number represents the number of millimetres in circumference—No. 1 is 1 millimetre, No. 2 is 2 millimetres, and so on up to 45.

A great variety of shapes will be found in the instrument catalogues, but for general use we recommend olive-headed gum-elastic bougies, steel bougies after the Sir Henry Thompson pattern, olive-headed catheters for stricture retention cases, and for prostatic retention cases *condé* gum-elastic with the Mercier curve.

A catheter or bougie must be smooth throughout, and care should be taken in choosing a catheter to see that there is no dead space in the tip beyond the eye which will act as a harbour for bacteria and grease.

If it is desired to tie in a catheter (catheter *à demeure*) the self-retaining catheter of Pezzer may be employed or an Escat's muzzle, or a gum-elastic catheter can be passed and a safety-pin pushed through it just outside the meatus to which tapes are attached on either side. The tapes are fixed to the sides of the penis with strapping.

(For precautions in passing a catheter see p. 278.)

Cleansing and Sterilisation of Instruments.

After the use of any instrument it should be wiped clean

of grease, and then rinsed and syringed through with hot soda solution to remove the remainder of the lubricant.

Metal and rubber instruments should be boiled and dried before being put away. Metal instruments can be dried in spirit, or wiped dry while still hot and put away in a dry case. To dry the interior of a metal instrument twist a little cotton-wool round the end of the stylet, soak it in 98 per cent. spirit and push it through the catheter.

The old gum-elastic catheters could not be boiled, but the modern catheters will stand being plunged into boiling water for a few minutes without degenerating, so that this method of sterilisation can now be adopted and is especially advisable in dealing with a nerve case.

Ureteric catheters can be sterilised without degeneration of fabric if they are boiled for five minutes in a saturated solution of ammonium sulphate, or they can be wrapped in lint and hung in a steam steriliser for two hours, or they can be sterilised by the formalin method.

Two other methods may be employed for the sterilisation of gum-elastic instruments.

1. *The dry method* by means of formalin vapour.
2. *The wet method* by means of corrosive sublimate solution.

All traces of grease must be removed before applying either of these methods, and before passing an instrument so sterilised it should be laid out in sterile water or boracic lotion to remove the irritating strong antiseptic on the sides of the catheter.

1. The Formalin Vapour Method.

A closed metal chamber is required with a tray on the floor and shelves above to hold the catheters. Two drachms of 40 per cent. formalin are poured into the tray, and the chamber is closed for twelve to twenty-four hours. After this time the formalin is removed and the instruments lying in the chamber are ready for use.

Glass tube sterilisers are on the market with patent india-rubber corks which have a small chamber to contain "para-form powder," a powder that gives off formalin vapour. The instruments are dropped into the glass tube and corked up for twenty-four hours in the vapour.

Instruments must be thoroughly dried before being exposed to formalin vapour. A simple method is to drop them for a moment into spirit and then blow them dry with a bellows.

Another method is to place them in a closed chamber which contains powdered calcium chloride in one corner.

Twenty-four hours' exposure to formalin vapour at the temperature of the air is required to render a small catheter sterile, but if the formalin be made to evaporate by heat the process can be completed in half an hour's exposure. Formalin ovens are now on the market, and are most efficient for use in large institutions where many instruments are needed in the course of the day. The instruments are cleaned, dried, and placed on the shelves, and a measured quantity of formalin vapour poured into the tray and heated for twenty minutes. After an hour the formalin vapour is pumped out of the oven through a tube which leads into the open air.

2. The Wet Method.

The instrument, freed from grease, is dropped into a solution of 1 : 1000 corrosive sublimate and left to soak for twenty-four hours. After that time it is removed to a dry glass tube which has been sterilised by boiling, is corked up, and left on its end to dry. If gum-elastic catheters are to be put away in a case for some time they must first be dried. The drying can be effected by dropping them into methylated spirit and then blowing them through with a bellows, or a dish of calcium chloride can be placed in one corner of the case as a dehydrating agent.

Lubricants.

The disadvantage of oily lubricants is that they are difficult to clean off the catheter after use and so prevent proper sterilisation. The advantage is that they are most efficient lubricants.

The advantage of glycerine is that it is easily cleaned off as it is soluble in water, but it is a most inefficient lubricant, and the patient is therefore tempted to rub the glycerine all over the catheter with his finger—a dangerous practice.

The oils, such as parolene and olive oil, can be sterilised by heating them in a Turkish coffee-pot on the top of boiling water for some minutes, and keeping them covered up lying on the top of the water (see p. 278), or they can be put up in short glass tubes sterilised by heat (212° F.) and corked with cotton-wool.

Another efficient method for general use is to put up vaseline, sterilised by heating it to 212° F., in a sterilised tin

squeezer with a screw top. This should be ordered an ounce at a time, so that each lot is finished before it has had time to be contaminated from frequent use.

Glycerine can be heated to the temperature of boiling water, as described above for the oils, or it can be heated to 212° F. and put up in sterilised glass bottles. "Katheter-purin" is prepared after Casper's formula and consists of glycerine, tragacanth and oxycyanate of mercury. It is sterile, but is rather disappointing as a lubricant unless quite fresh.

The best lubricant for general use is parolene sterilised and kept as advised above, but for cystoscopic work some preparation of glycerine is required as it does not fog the lenses of the instrument.

APPENDIX.

Extract of a Paper by Schade, "Beiträge zur Konkrementbildung," 'Münchener med. Woch.,' Nos. 1 and 2, 1909.

THE origin of primary renal calculi is not yet clear despite the work of Ebstein, Moritz and Pfeiffer [and of Rainey and Ord, not mentioned by Schade]. So far the fact has not been sufficiently appreciated that the salts in the urine cannot be dealt with as simply watery solutions of these salts, as the urine contains, in addition to the salts, more or less *colloid* in suspension, such as urochrome, mucin, albumen, etc. The behaviour of salts in the presence of suspended colloids must be considered.

Undoubted colloids, such as mucin and albumen, appear to go into solution, but if submitted to tests it is found—

1. They do not affect the osmotic pressure.
2. They do not dialyse.
3. With the ultra-microscope they can be seen to exist as countless refractile particles.

Colloids can be suspended in solution—(1) in large droplets; (2) in fixed particles. When passing from 1 into 2 there is an enormous increase in the surface of the colloid presented and *vice versâ*.

It is also necessary to consider the power of *adsorption* possessed by these colloid particles when salts are added to the containing fluid.

Schematically the urine is a salt solution lying in the spaces of an extremely fine scaffolding of jelly (colloid) material. A part of the dissolved salts becomes *adsorbed* on the surface of the colloid particles, and is held fast there in higher concentration than elsewhere. The particles so load themselves with salt that they alter the saturation co-efficient of a salt, and raise the solubility limit. The "strikingly raised solubility of uric acid" has often been a subject of speculation. These facts explain why uric acid is so much more soluble in urine than in distilled water, the uric acid being adsorbed on to the

surface of the particles of urochrome. There are, therefore, two saturation points for any given salt: (1) In distilled water; (2) in a colloid suspension (solution).

If a salt is added to the urine in increasing quantities a point is reached beyond the saturation point for a colloid solution, and precipitation begins at the places where there is the greatest concentration. This is on the surface of the colloid particles. The salt, therefore, precipitates itself on the surface of these particles, and brings down with it a sediment of colloid, which is closely bound up with the salt. This explains the well-known fact that every crystal deposited from the urine has an organic (colloid, albuminous) skeleton. [The shape of the crystal is modified by the colloid (Ord).]

The insolubility of stones once formed can be explained. This insolubility is evidence in itself that in the case of a renal calculus a mere precipitate of crystals is not being dealt with. A crystal is "reversible"—that is to say, it goes into solution again if the containing fluid is not saturated with the salt. A stone does not do this owing to its possessing an albuminous organic colloid matrix which is "irreversible."

Colloids are—(1) reversible; (2) irreversible.

Mucin, for instance, is a reversible colloid, as after it has separated out of urine as a cloud it can be made to go into solution again if an alkali be added. The same is true for deposits of phosphates entangled in mucin seen in cases of cystitis.

"Urochrome" is likewise a reversible colloid, and the "uric acid infarcts" of the infant kidney are simply precipitates of uric acid around urochrome particles, and are "reversible." Hence the importance of flushing the infant's kidney with plenty of water.

In the production of all other calculi an "irreversible colloid" is present as the organic framework. Such colloids are absent in normal urine, but *not so in pathological urines.* For instance, fibrin is a typical irreversible colloid, coming from fibrinogen in suspension, but incapable of being passed back into solution again as fibrinogen. If a stone be subjected to the action of acid formol the crystals are dissolved out, but the organic framework is left. Amorphous stones are produced when the sediment is very abundant and the fibrin very scanty. Otherwise lamination is seen. No satisfactory explanation can be given for the fact that fibrin tends to deposit itself in laminæ. The fact is seen in lamination of blood-clots. Iron-stones in springs are laminated and are

deposited from colloid oxyhydrate and carbonate of iron. The same is true of the pisoliths found in the springs at Vichy and Carlsbad.

Hence, if there is bleeding into, or inflammation of, the urinary tract, fibrin is thrown out in the urine and can become the framework for stones. Whether the colloid basis is always fibrin is very hard to decide, as there is no absolute test enabling an observer to distinguish fibrin from other irreversible colloid albumens. But the probability is that fibrin is the common irreversible colloid required to be present before a renal calculus can be formed.

Fibrinuria seems to be a very rare disease, but it is possible that very slight cases are more common than is at present recognised. When inflammation or bleeding has occurred it is easier to understand how stone might follow.

By following out these ideas Schade has been able to reproduce calculi in the test-tube.

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